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ERCP wire systems: The long and the short of it

Shilpa Chandrupatla Reddy, Peter V Draganov

Shilpa Chandrupatla Reddy, Department of Medicine, University of Florida College of Medicine, Jacksonville, Florida 32610, United States

Peter V Draganov, Department of Gastroenterology, Hepatology and Nutrition, University of Florida, 1600 SW Archer Rd, Room HD 602, PO Box 100214 Gainesville, Florida 32610, United States

Author contributions: Reddy SC and Draganov PV contributed equally to this work.

Correspondence to: Peter V Draganov, MD, Department of Gastroenterology, Hepatology and Nutrition, University of Florida, 1600 SW Archer Rd, Room HD 602, PO Box 100214 Gainesville, Florida 32610, United States. dragapv@medicine.ufl.edu

Telephone: +1-352-392-2878 Fax: +1-352-392-3618

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Abstract

Guidewires are routinely used at the time of endoscopic retrograde cholangiopancreatography (ERCP) to gain and maintain access to the desired duct and aid in the advancement of various devices. Limitations of the traditional long-wire systems have led to the introduction of three proprietary short-wire systems. These systems differ in many respects but share two main principles: They lock a shorter wire in position to allow advancement or removal of various devices without displacement of the wire and they all allow for physician control of the wire. In this comprehensive review, we describe the key features of the three currently available short-wire systems: RX, Fusion and V systems. We also focus on the potential benefits and drawbacks that accompany the short-wire concept as a whole and each specific system in particular. Although the available data are limited, it appears that the use of the short-wire systems lead to reduced procedure, fluoroscopy and device exchange times, decreased sedation requirements, improved wire stability and increased endoscopist control of the wire. Furthermore, the physician-controlled wire-guided cannulation has the potential to decrease ampullary trauma and the rate of post-ERCP pancreatitis. The short guidewire systems appear to be an improvement over the traditional long-wire systems but further studies directly comparing the two approaches are needed.

Key words: Endoscopic retrograde cholangiopancreatography; Guidewires; V-system; RX system; Fusion system

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INTRODUCTION

Guidewires are an essential part of both diagnostic and therapeutic endoscopy. They are used to gain or maintain access into a lumen or cavity. In addition, they have an integral role in the advancement of a variety of devices[1]. Guidewires vary in material, length, diameter, and design to aid in specific situations encountered by the endoscopist during a procedure.

The construction of guidewires is designed for use depending on their individual qualities. Monofilament wires are made with stainless steel and are used for their rigidity[1]. Coiled wires have an inner monofilament core which has the quality of stiffness accompanied by an outer spiral coil encompassing durability and flexibility[1]. Lastly, coated or sheathed wires have a monofilament core made of stainless steel, nitinol, or other alloys, whereas the outer sheath may be made of teflon (DE), polyurethane, or another polymer[1]. Many wires have platinum or tungsten dipped cores to enhance visualization during fluoroscopy. Tips have various designs such as straight, angled, J-shaped, or tapered. Wires can range from 150-650 cm in length and from 0.46-0.97 mm in diameter. A common source of confusion pertaining to endoscopic retrograde cholangiopancreatography (ERCP) wires is the fact that it is customary to display the length of the guidewire in cm and the diameter in inches.

Traditional guidewire usage requires advancement under direct visualization through the endoscope with or without fluoroscopy. Maintenance of the guidewire position is essential to the safety of dilating procedures and tube placements. Assistance with printed markers and movement guides on the wire can decrease the risk of displacement[2].

Applications for guidewire use in the gastrointestinal (GI) tract are vast. These include advancement of dilators, esophageal stents, manometry catheters, feeding tubes, colonic stents, stricture dilatation and endoscopic ultrasound (EUS)-guided biliary and pancreatic access[1]. Guidewires are an indispensable part of ERCP and are used to gain and maintain access to the desired duct, and provide a platform for insertion or withdrawal of various devices.

CHALLENGES WITH LONG GUIDEWIRE ERCP SYSTEMS

Traditionally, long wires were exclusively used at the time of ERCP. The long length is dictated by the need to exchange various devices over the wire. The length of a typical long wire used for ERCP ranges from 420 to 480 cm. This excessive length creates a number of problems. Since the assistant is in control of the wire and the physician is in control of the ERCP device, excellent communication between the physician and assistant is required. Failure to do so can lead to loss of access, more difficult cannulation, and problems with advancing the wire to the desired target. Furthermore, it is not uncommon for the end of the long wire to touch the floor leading to contamination. Finally, the assistant is challenged to perform multiple tasks at the same time including advancing or retracting the wire, injecting dye, operating the device (inflating/deflating the balloon, flexing/relaxing the sphincterotome *etc*) and doing all of that while making sure that the end of the wire does not touch the floor. Hydrophilic wires are even more prone to displacement from ducts and strictures, which may further contribute to difficulties with catheter exchanges[1]. Repositioning or loss of access to either the bile or pancreatic duct may lead to increases in procedure duration, radiation exposure to patients and staff, failure to place a stent and even perforation[3].

BACKGROUND OF SHORT GUIDEWIRE ERCP SYSTEMS

At the time of ERCP the use of long guidewires is dictated by the need to exchange various devices over the wire. Therefore, the length of the wire should be, at a minimum, twice the length of the device. Recently, advances in catheter technology combined with wire locking systems provided for the development of short-wire ERCP systems. The main feature of all short-wire ERCP systems is the ability to lock the short-wire in position to allow advancement or removal of various devices without displacement of the wire. In a single-center pilot study, Beilstein *et al*[3] have shown that using a prototype duodenoscope (XTJF-140V2F; Olympus America Corp., Melville, NY., USA) led to a shorter exchange time when compared to standard duodenoscopes, and attributed the benefit to the guidewire locking system and fewer instances of repositioning. This milestone study demonstrated that fixation of the guidewire by the endoscope elevator can substantially improve device exchanges over a shorter wire length. However, additional goals of this new innovation included maintaining ductal access, decreasing procedure time, and reducing sedation and fluoroscopy exposure[3]. Endoscopy assistants are and have been essential to the successful use of ERCP, but the ability of the endoscopist to independently manage the guidewire and the scope was considered an advantage during these procedures.

The emergence of short-wire systems evolved in order to counter limitations of the traditional long wires. All short-wire systems share three independent elements including a means of locking the wire in position during a device exchange, exchanging devices over short-wires while maintaining access and decreasing wire lengths between 185 and 270 cm[4]. Device exchanges over a short guidewire are possible by either fixation of the wire externally at the biopsy port or internally at the elevator. Both external and internal lock designs allow physician control of the guidewire at or near the biopsy port. However, the external and internal lock designs differ in many ways. The external lock design uses suction port caps and allows fixation of the wire with all maneuvers except the limited insertion or withdrawal of the leading short-track portion of the device past the biopsy port[4]. In contrast, the internal lock system can be used with either short or long wire devices. When locking occurs at the level of the ERCP scope elevator, assistant control of the wire is needed when devices are passed beyond the elevator.

TYPES OF SHORT GUIDEWIRE ERCP SYSTEMS

There are three available short-wire ERCP proprietary systems. These systems integrate cannulation, sphincterotomy, balloon extraction, balloon dilation and biliary stenting devices. The same short-wire devices can be used with traditional long wires if needed.

The RX system, (Boston Scientific Corporation, Natick, MA, USA) was the first short-wire system introduced in 1999. This system incorporates three components. The RX Locking Device has an external lock that may accommodate fixation of one or two wires. A special biopsy port cap minimizes any air or bile leakage during the procedure. RX Compatible Biliary Devices include both open "tear away" channel monorail designs used with sphincterotomes and catheters, as well as short-track designs used with cytology catheters, stone extraction balloons, dilating balloons and stents. The last component includes the 260-cm long 0.035-inch or 0.025-inch wide Jagwire with a coated firm shaft, flexible hydrophilic leading tip and two colored markings, which aid in detection of wire movement[4]. Use of the 0.035-inch Jagwire, in conjunction with an ultra slim upper endoscope (GIF-XP 160, Olympus America,

Table 1 Differences between the three short-wire systems

Characteristics	RX system	Fusion system	V-system
Type of endoscope	Standard	Standard	V-scope
Type of lock	External at the biopsy port	External at the biopsy port	Internal lock design
Type of device	Open channel tear-away	Close channel breakthrough	Close lumen device
Short-track technology	Yes	Yes	No
Wire length	260 cm	185 cm	270 cm
Can be used with standard guidewires	Yes	Yes	Yes
Can be used with 0.025″ or 0.018″ or angled wires	No	Yes	Yes
Can be used with hydrophilic Glidewire	No	Yes	Yes
Ability to flush wire channel	No	Yes	Yes
Intraductal exchange ability	No	Yes	No
Insertion of multiple stents without the need to recannulate	No	Yes	No
Physician control of wire	Yes	Yes	Yes
Pushability of short-wire devices[1]	++	+++	+++

[1]author own experience.

Center Valley, PA., USA), for maintaining access allowed for direct visualization of the biliary tree to aid in intraductal diagnosis and treatment[5]. The RX system does allow for long wire conversion in appropriate cases with a 200-cm wire attachment. The 0.025-inch and 0.035-inch diameter wire should be used with their respective devices which are not interchangeable.

The Fusion system (Cook Endoscopy; Winston Salem, NC., USA) was introduced in 2004. As in the RX Biliary system, the Fusion system incorporates both short-track and tear-away capabilities. The external wire lock fits on the biopsy port, which enables the locking of one or two wires. A key feature of this system includes a side port that has been placed at 6 cm from the distal tip of any catheter and a closed tear-away channel running the length of the catheter (as opposed to the open tear-away channel of the RX). The availability of a side port near the device tip allows for a true intraductal exchange. With the intraductal exchange, the wire can be disengaged from the device while both are still within the biliary or pancreatic ducts. The device then can be withdrawn while the wire remains in place. Short-track Fusion push catheters are available for both 5F and 7F stents. The Fusion Guidewire, although not extendable, is 0.035 inches in diameter and 185 cm in length with similar features to the Jagwire[4]. Studies from Europe and the US have shown improved placement of multiple stents into the bile duct, or pseudocyst cavity minimizing the number of guidewires used and shortening procedure duration[6,7]. The ability to move from the short-wire system where the physician has control of the wire to the long wire system where there is reliance on an assistant at any point during the procedure is a real advantage of the Fusion system. This system also provides compatibility with all other systems including all hydrophilic wires such as the Glidewire (Boston Scientific Corporation) available commercially.

The V-system (Olympus, Tokyo, Japan) was introduced in 2005. This is the first modification of a duodenoscope for facilitation of wire exchanges[8]. The V-system scope elevator lever includes a V-shaped groove and an increased angle of articulation in comparison to the standard Olympus TJF-160 series endoscope. This design promotes securing and locking of the short guidewire at the elevator level to reduce repositioning of the guidewire during accessory exchanges[8]. The groove described above acts as the internal wire lock allowing use of a catheter without a short-wire track. The V-system devices are similar to the traditional long wire devices at the leading end but have a different design component at the external end[4]. Device manipulation may be simplified by the LinearGuideV, a 0.035-inch diameter, 270 cm long wire with a hydrophilic coating over the leading 50 cm[4]. Spiral markings have been placed starting at 130 mm from the distal end, extending to the proximal end for easier attachment of the LinearGuideV into the V-Groove. The C-Hook allows the device handle to be attached to the V-Scope. This enables the endoscopist to maneuver the guidewire, inject contrast and manipulate the device handle while keeping a grip on the device control section. The main advantage of the C-Hook is that it is very easy for the endoscopist to relinquish control of the guidewire back to the assistant if needed. The main differences between the three available short-wire ERCP systems are summarized in Table 1.

BENEFITS OF SHORT GUIDEWIRE SYSTEMS

One of the main benefits of the short-wire systems is clearly associated with the ability to permit physician-controlled guidewire cannulation of the desired duct. Cannulation is the essential initial step during ERCP and can be challenging for the endoscopist. Median time to successful cannulation was shown to be shorter in a wire-assisted cannulation compared to cannulation achieved after first injecting contrast (120 s *versus* 150 s) ($P = 0.73$)[9]. When used by an experienced endoscopist, Katsinelos *et al*[10] showed that use of a 0.035-inch Jagwire provided an 81.4% success rate for deep common bile duct cannulation *versus* 53.9% using a standard catheter ($P < 0.001$). Although rates of successful cannulation were similar between the two groups (hydrophilic guidewire 83.8% *versus* standard catheter 84%) if instrument crossover occurred[10].

Development of the RX Biliary system in 1999 has led to increased control of the guidewire and exchange by the physician, decreased hand and wrist force used during contrast injection, and in return improved physician stress, efficiency, and speed. The changes in guidewire design and physician control of the wire can be expected to reduce ampullary trauma and lead to decreased complication rates and post-ERCP pancreatitis (PEP) in particular[11].

The studies to date have yielded conflicting results regarding the role of guidewire cannulation and prevention of PEP. Lella *et al*[12] conducted a prospective study with 400 patients randomized to either Group A with a guidewire used to access the pancreatic duct and endoscopic sphincterotomes, and Group B with a traditional catheter plus injection technique used. The rate of PEP was 0% in Group A *versus* 4.1% in Group B. One study which randomized patients to either primary contrast or guidewire-assisted cannulation (Jagwire; Boston Scientific Corporation) showed improvements in rates of cannulation, however, there was no reduction in the incidence of PEP (7.9% with guidewire and 6.2% with contrast). Increased attempts at cannulating the papilla demonstrated increased rates of PEP with > 10% after four or more attempts[9]. No difference in the rates of post-procedural pancreatitis after cannulation was shown by Katsinelos *et al*[10] (standard catheter 7.8% *versus* hydrophilic Jagwire 0.035-inch guidewire 5.4%).

Guidewire manipulation of the ampullary surface has been suggested to be less traumatic than contrast injection or forceful manipulation with a catheter. Double wire use is helpful in cannulation of the common bile duct. Pancreatic duct guidewire placement can be used to facilitate cannulation into the choledochus portion of the common bile duct by maintenance of orientation for the endoscopist[13-15].

A major advantage of the short-wire system is the potential for shorter procedure and fluoroscopy time. Papachristou *et al*[16] showed that using the V-system endoscope and accessories with a short hydrophilic wire (Glidewire; Boston Scientific Corporation) can lead to rapid and reliable device exchanges with only a 5% chance of wire loss. In some exchanges the authors used the so called "hydraulic technique". The hydraulic technique uses standard techniques to achieve access with the Glidewire and catheter until all available wire is inserted into the catheter. Then, water is flushed under pressure into the catheter, keeping the wire in place, while the catheter is removed by the endoscopist after confirmation of the wire position[16,17]. Over half of the instances of wire loss were either unrelated to the exchange or required minimal adjustment due to partial loss. All endoscopists regained wire access and one endoscopist was able to reduce his average number of guidewires used per case from two to one[16]. The use of continuous fluoroscopy was also avoided with maintenance of the Glidewire position. The technique described above can permit access to the pancreaticobiliary tree and allow stent insertion in complicated cases with less difficulty than standard methods. The ability of the V-scope to hold the Glidewire varied between exchanges regardless of endoscopic position, but still resulted in faster exchanges than a regular duodenoscope with no change in wire loss rates[16].

A prospective multicenter, randomized and controlled trial was conducted by Joyce *et al*[8] to compare the V-system (Olympus XTJF-140V2F) with the traditional duodenoscope and accessories. The V system scope elevator lever includes a V-shaped groove and an increased angle of articulation in comparison to the standard Olympus TJF-160. The V-system was found to have both reduced rates of guidewire adjustments and time needed to complete accessory exchanges over a guidewire when compared to the traditional system. Reduction in exchange time between the V-system and the conventional system was 19.4 s *versus* 31.7 s ($P < 0.001$)[8], whereas the need to reposition the guidewire was required less often with the V-system, 9.4% *versus* 35.7% ($P = 0.0005$)[8]. In contrast, the reduced procedure and fluoroscopy times were not found to be statistically significant[8]. Failure to secure the guidewire leading to loss of access occurred in 11% of cases[8]. Reasons for loss of access varied from unfamiliarity with the system to nuances with the use of the guidewire and the elevator.

The intraductal exchange technology offered by the Fusion system allows the guidewire to be detached from the catheter within the bile or pancreatic duct. When aggressive endoscopic management is necessary for drainage of pancreatic pseudocysts, this system allows for placement of a number of plastic stents with less effort than traditional methods[6]. There is elimination of both exchange outside the endoscope and multiple cannulations for reentry into the ducts or the pseudocyst cavity. Use of a second guidewire through a cystotome and the intracystic wire exchange technique secures access to the pseudocyst[6].

Preliminary data from a prospective randomized single-blinded trial with 46 patients that compared performance characteristics of the short-wire ERCP system (Fusion) and a standard long wire system (DASH), showed a trend towards shorter procedure times and shorter time to perform various ERCP maneuvers with the short-wire system[7]. A statistically significant reduction in stent insertion times were also observed during this study ($P = 0.001$).

Sai *et al*[18] used the Fusion system for placement of double plastic stents for the palliation of lower biliary obstruction associated with unresectable pancreatic cancer. Successful stenting was accomplished in 94% (15) of patients with two requiring balloon dilatation of the stricture. No complications related to stent insertion and retrieval occurred. Mean patency duration was 151.1 d.

Johlin *et al*[17] at the University of Iowa described the use of a standard catheter-type device in combination with a short 0.035-inch guidewire (240 cm in length). The authors used a 3-mL syringe and sterile water to perform hydraulic exchanges as described earlier. They documented that the entire hydraulic ERCP catheter

Table 2 Short-wire system potential advantages

Advantages
Reduced exchange times
Reduced stent insertion times
Maintenance of ductal access
Reduction of sedation and fluoroscopy time
Increased endoscopist control of cannulation
Locking of wire in position to increase stability
Decreased rates of post-ERCP pancreatitis
Decreased trauma when ampullary surface is manipulated
Reduced rates of wire adjustments
Aids in stricture access
Allows placements of multiple stents (Fusion system only)

exchange took less than 30 s. Over the past 10 years this system was shown to save time, save money, maintain capacity to aspirate bile and pancreatic fluid and decrease contamination (if a short-wire is accidentally dropped it will not touch the floor). Tables 2 and 3 summarize the potential benefits and drawbacks of the use of short-wire systems.

Table 3 Short-wire system potential drawbacks

Drawbacks
Only preliminary studies have documented the potential benefit of the short-wire systems (all systems)
Hydraulic exchange technique not plausible with RX system
Decreased pushability with the open channel design of the RX system
Inability to flush channel for hydrophilic wire use (RX system)
Inability to use smaller than 0.035 inch or angled wires when channel is torn after first device exchange (unless device is preloaded) (RX system)
Deterioration of the device after multiple exchanges (RX, Fusion systems)
No easy method for insertion of pancreatic stents (all systems)
No reliable method of locking wire (V-system)
Looping of wire between the biopsy port and the external locking device (RX, Fusion systems)
Poor guidewire visibility (V-system)
Air and bile leakage causing increased soiling of operators (RX, Fusion systems)
Wires may suspend freely in air after being locked jeopardizing operators (all systems)
Loss of visibility due to decreased distention of the duodenum (RX, Fusion systems)

DRAWBACKS

Although there are many benefits to the short-wire system, there have been some inefficiencies associated with them. One study showed that by using a dedicated short-wire monorail catheter with an accessory system (the RX system), slower exchange times by an average of 4 s were observed when compared to standard accessories. The RX system is not amenable to the hydraulic exchange technique[16]. In contrast to other studies, one prospective study showed that the time required for primary selective common bile duct cannulation was increased in the hydrophilic guidewire group at 4.48 ± 0.32 min *versus* the standard catheter group at 3.53 ± 0.32 min[10]. Other potential problems: decreased pushability due to the open channel design (RX), inability to flush the channel to facilitate use with a hydrophilic wire (RX), inability to use smaller than 0.035 inch or angled wires after the channel is torn with the first device exchange (unless the device is preloaded) (RX), deterioration of the device after multiple exchanges (RX, Fusion), not being able to insert pancreatic stents easily (all), no reliable locking of the wire (V), looping of the wire between the biopsy port and the external locking device (RX, Fusion), poor guidewire visibility (V), air and bile leakages which may lead to soiling of the operator and loss of visibility due to decreased distention of the duodenum.

SAFETY

The safety of short-wire systems has not been addressed exclusively in any published studies. Damage to the guidewire may occur with external locking of the wires. In addition, the proximal end of the shortest wire freely suspends in air after being locked and can present a risk to the operator, assistant, or patient[4]. Antileak caps should consistently retain air and bile preventing any spray of secretions but failure of this feature may lead to adverse outcomes.

When using the internal locking endoscopes, inappropriate locking of the wire leading to access loss may require repeated cannulation of the guidewire. As devices are introduced when using the internal locking endoscopes it is important that the V-shaped elevator is engaged properly[4]. If there is difficulty, it is important to note if there is damage to the tip of the device or catching of the guidewire in the space between the V-groove and the working channel[4].

Guidewire insertion into the bile duct improves the safety margin of a sphincterotomy by ensuring the incision of the biliary sphincter as intended. As mentioned before, this allows for repeated cannulation decreasing any risk of papillary injury if the papillotome becomes dislodged[12].

A search of the Maude database for all three short-wire system manufacturers was carried out and only adverse events regarding the Wallstent RX Biliary (Boston Scientific, Galway, Ireland) were listed. Adverse events included distal biliary duct stent occlusion 7 d after placement, hyperplasia at the site of the distal common bile duct stent 10 mo after placement during a stricture revision procedure, and a stent was found to have "foreshortened and proximally migrated into the bile duct" 1 year after placement. These complications were most likely related to the Wallstent design rather than to the use of the RX system.

COST

Using the short hydrophilic 0.035-inch biliary guidewire as the sole guidewire during a procedure decreases the need for a second wire, which may minimize cost during ERCP[16].

CONCLUSION

The practice of using ERCP short guidewire systems was developed to improve procedural outcomes. Although the use of traditional guidewires is vast amongst endoscopists, exposure to these systems may aid physicians to reduce exchange times, increase endoscopist control, reduce sedation exposure, reduce fluoroscopy time, increase stability with integrated lock systems and decrease rates of trauma during the procedure.

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