For Healthcare Professionals

Endoscopist Case Report ~Clinical Value of IEE in ERCP~

The effectiveness of TXI/RDI in Biliopancreatic Endoscopic Diagnosis
- Benefits of improved visibility through IEE

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Back-ground

March 2014: Graduated from Gunma University School of Medicine
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1 Flagship models for biliopancreatic endoscopy: TJF-Q290V and EVIS X1

Olympus has released the flagship models for their biliopancreatic endoscopy systems: EVIS X1™ and TJF-Q290V™. The TJF-Q290V, released in January 2019, is a therapeutic duodenoscope released as the successor to the JF-260V (released in 2004) and TJF-260V (released in 2006). While maintaining a channel diameter of 4.2 mm as a TJF, improvements have been made in various aspects such as High Force Transmission performance of the shaft, reduction of the bending radius, increased strength of the center lock and addition of a side lock mechanism, disposability of the distal cap, improved image quality (Q image), and the ability to use TXI/RDI (Table 1).
The video processor EVIS X1 was released in July 2020, featuring Texture and Color Enhancement Imaging (TXI) and Red Dichromatic Imaging (RDI) as part of its Image Enhancement Endoscopy (IEE) capabilities. Until now, Narrow Band Imaging (NBI) has been widely used as an Image Enhancement Endoscopy (IEE) to improve diagnostic performance. With the introduction of TXI and RDI, IEE can now also be used during treatments[1].
This report will discuss the characteristics of the TJF-Q290V and the usefulness of TXI and RDI, including case studies.

	TJF-Q290V	TJF-260V	JF-260V
Distal end outer diameter (mm)	Ø 13.5	Ø 13.5	Ø 12.6
Distal cover	Disposable	Re-use	←
Insertion tube outer diameter (mm)	Ø 11.3	Ø 11.3	←
Instrument channel diameter (mm)	Ø 4.2	Ø 4.2	Ø 3.7
Image Quality	Q image	Normal image	←
Viewing direction	105° (Backward side viewing 15°)	←	←
Insertion section	High Force Transmission insertion section	Conventional insertion section	¥
Guidewires fixation	Center lock (increased strength) + side lock	Center lock only	←
Forceps elevation wire	Internalization	Exposure	←
Field of view	100°	←	¥
Angulation angle U/D/R/L	120° /90° / 110° /90°	←	←

Table1

2 Clinical benefits of the TJF-Q290V

High Force Transmission performance contributes to more precise diagnostic treatment

The High Force Transmission insertion section has been improved to ensure that the force applied by hand is transmitted without loss all the way to the tip of the scope. In cases where the duodenum becomes hard and narrowed due to tumors or inflammation, it is often difficult to pass through the stenosis or perform precise maneuvers, and even if the scope reaches the papilla, its operation may be restricted due to poor scope positioning. With the High Force Transmission performance of the TJF-Q290V, we believe it can achieve successful outcomes even in challenging conditions, including passing through stenosis, performing precise operations at the papilla, and successfully placing multiple biliary stents (Fig. 1).

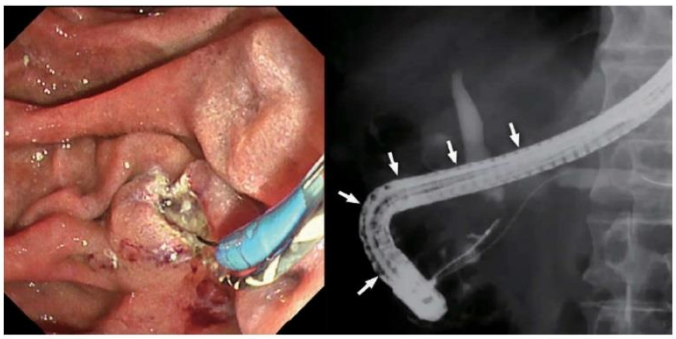

Fig. 1: Using the TJF-Q290V, it was possible to successfully complete the pancreatic duct guidewire placement procedure, needle knife precut, and stent placement despite poor scope positioning due to sclerosis (arrow) caused by pancreatic head cancer

Selection of Duodenoscope According to the Case

The distal end diameter of the scope is Ø 13.5mm, which is equivalent to the TJF-260V, but the maximum outer diameter is slightly larger to accommodate the disposable distal cover (Fig. 2). When comparing the shape of the scope tip, the TJF-Q290V's tip appears slightly angular, but it is chamfered and rounded (Fig. 3). While some caution is needed when passing through the pharynx, the TJF-Q290V can be used without issues in nearly all cases, except those with severe esophageal or duodenal strictures requiring balloon dilation. Therefore, it is the first choice for almost all cases.

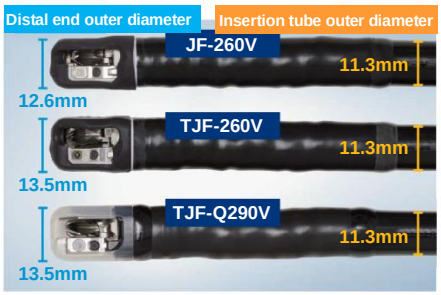

Fig. 2: Comparison of scope diameters

Fig. 3: Comparison of scope tip shapes

Increased elevation angle, allowing for handling more challenging cases with a forceps elevator

By modifying the shape of the forceps elevator, improvements have been made such as internalization of the wire, increased strength of the center lock, ability to use center lock and side lock, and enhancement of the catheter's angulation at the tip (Fig. 4).
Due to the increased strength of the center lock, there is minimal risk of the guidewire accidentally dislodging during prolonged procedures and multiple device exchanges. Furthermore, with the official adoption of the side lock mechanism, damage to the guide wire during side lock operations is also prevented.
Of particular note is the angulation at the tip of the catheter. In actual intubations with the TJF-Q290V, even in cases involving Long NDS (narrow distal segment), it is possible to achieve a clear upward angulation of the catheter, facilitating easy alignment with the bile duct. Since the upward angulation is not specified in the catalog, we compared how far we could raise the catheter tip in the Up angle Max + Raise Max condition with each scope. The TJF-Q290V can achieve a strong upward angle of the catheter with just the forceps holder alone (Fig. 5). Furthermore, with the scope's Up angle and shortened curvature radius, adding Up angle Max allows for even stronger catheter angulation (Fig. 6), enabling the catheter tip to reach high points even in papilla models (Fig. 7).
Depending on the shape of the duodenal lumen or the papillary region, there are situations where it is necessary to significantly elevate the catheter to align with the bile duct axis. In such cases, the performance of the forceps holder can make a significant difference.

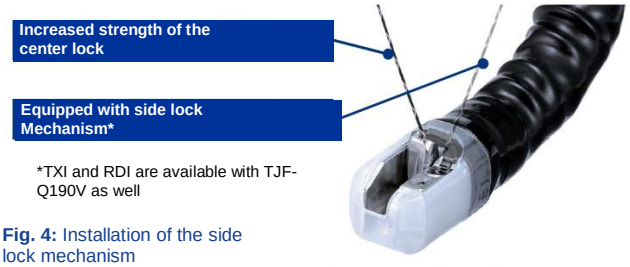

Fig. 4: Installation of the side lock mechanism

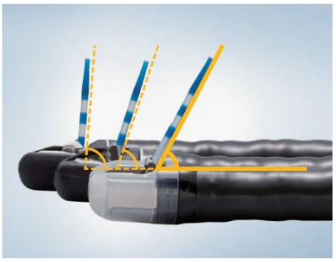

Fig. 5: Comparison of catheter positions with forceps maximum elevation. From front to back: TJF-Q290V, TJF-260V, and JF-260V.

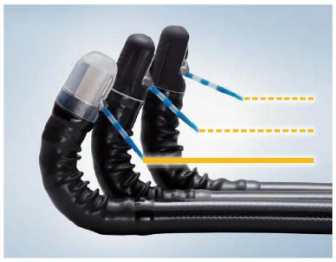

Fig. 6: Comparison of catheter positions with forceps maximum elevation + up angle maximum. From front to back: TJF-Q290V, TJF-260V, and JF-260V.

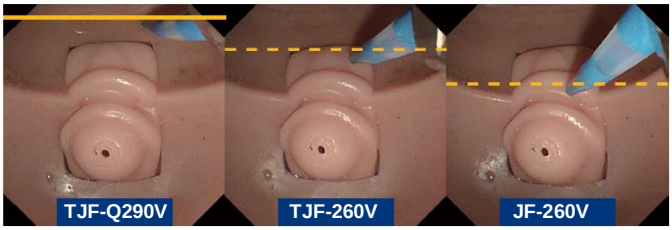

Fig. 7: Comparison of catheter tip reach points in the model

Expanding the treatment capabilities with a large-diameter instrument channel of 4.2mm

The TJF-Q290V is equipped with a 4.2mm diameter channel. Devices that can only be used with the 4.2mm channel include the cholangioscope CHF-B290, lithotripsy basket (super-hard type), and 12Fr stents. Moreover, in cases like hilar bile duct stenosis, it may be necessary to place multiple guide wires or stents. With a 4.2mm diameter, it is possible to place three wires simultaneously and perform stent placement of 8.5-10Fr while the wires remain in place. Additionally, it allows for simultaneous deployment of two 6Fr metallic stents and supports the "Two devices in one channel method." Furthermore, when removing stents such as 10Fr plastic stents or metallic stents, it is possible to remove them through the channel with caution, even considering thicker stents.

3 Image processing techniques applicable to biliopancreatic endoscopy: TXI and RDI

TXI and RDI can be used with the 290 series and later models.* TXI is compatible with the TJF-Q290V side-viewing endoscope, while RDI can be used with the SIF-H290S single-balloon enteroscope.

TXI is an image processing technology that enhances visibility by emphasizing structure (texture), brightness, and color tone. It offers Mode 1, which emphasizes all three elements, and Mode 2, which reduces emphasis on color tone (Fig. 8). Mode 2 provides a more natural color tone closer to WLI, allowing comfortable use over extended periods

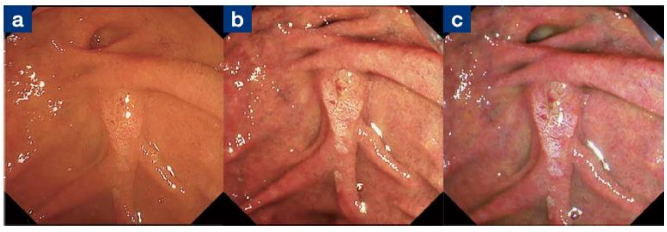

Fig. 8. a. WLI, b. TXI Mode 2 (structure + brightness enhancement), c. Mode 1 (structure + brightness + color tone enhancement)

without discomfort. We typically switch to Mode 1 after using Mode 2 when they need to further emphasize color tones.
RDI is an IEE that RDI utilizes differences in the reflection and absorption characteristics of hemoglobin at light wavelengths to enhance visibility by providing contrast for blood and blood vessels. Three types of light sources — Red (630nm), Amber (600nm), and Green (540nm) — are used, and Modes 1-3 are available depending on the degree of color enhancement (Fig. 9).[1] In areas where the blood concentration is low, both Red and Amber light are reflected, resulting in an orange appearance. However, in areas with higher blood concentration, the reflection of Amber light is reduced, making these areas appear red. This contrast makes it easier to identify the presence and location of active bleeding. To make bleeding points more visible, Mode 2, which emphasizes Red more, is primarily used.

*and 190 series.

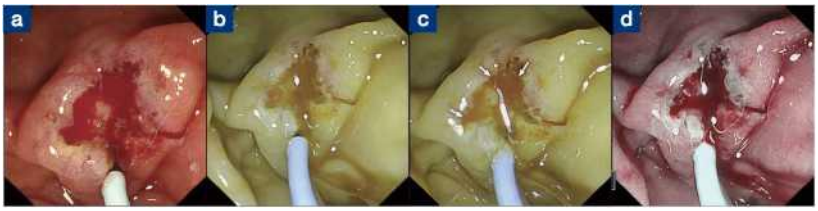

Fig. 9: Comparison of a. WLI and RDI (b. Mode 1, c. Mode 2, d. Mode 3) in post-EST bleeding

4 Clinical Applications of TXI

TXI enhances visibility by emphasizing structure, brightness, and color tone. In general endoscopic procedures, understanding anatomy and structure is crucial, and TXI is believed to be a significant aid in this regard. In normal papilla, it is also useful for identifying the bile duct orifice, identifying the bile duct orifice during precutting, and identifying stenosis at the biliary-enteric anastomosis. Furthermore, in tumors of the papilla, enhanced visibility of lesion boundaries and bile duct orifice is expected.[1]

1) Recognition of the Bile Duct Orifice

The recognition of the bile duct orifice becomes easier with the emphasis on the depressions and elevations of the bile duct opening, facilitating the identification of papillary shape and opening. Especially in cases like flat-type papillae (Fig. 10) and intraductal papillae (Fig. 11, Video)[2] in Case 1, even when the bile duct opening is not clearly visible under white light (WLI), TXI enables clearer visibility.

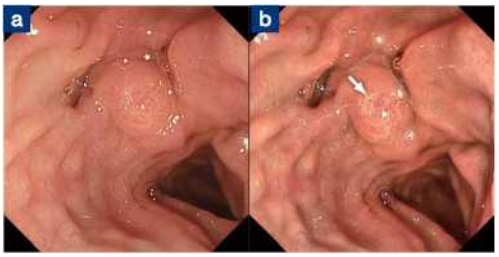

Fig. 10: Flat-type papilla
a. Unclear orifice under WLI, b. TXI Mode 2

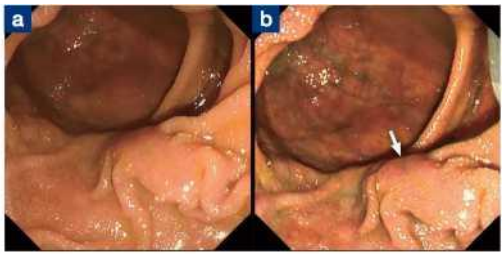

Fig. 11: Intraductal papilla
a. WLI - unclear opening, b. TXI Mode 2 - highlighted concavity of the opening (arrow) improving visibility

Fig. 11: Insertion into intraductal papilla using **TXI Mode 2**

2) Needle knife precut

In cases of difficult bile duct cannulation, there are also cases that require Needle-knife precut. First, incise the duodenal mucosa at the enlarged papillary portion to expose the submucosal layer, and identify the white, band-like elevation believed to be the Oddi sphincter. Next, gradually extend the incision around the Oddi sphincter, exposing the red-colored bile duct mucosa believed to be the bile duct orifice, and place a catheter to facilitate drainage. After precut, the incision site often has poor visibility, making identification of the bile duct orifice difficult. However, TXI enhances visibility of structures such as elevations and depressions, as well as color tones, making it useful for recognizing the Oddi sphincter and bile duct orifice (Fig. 12, 13, Video).[2,3]

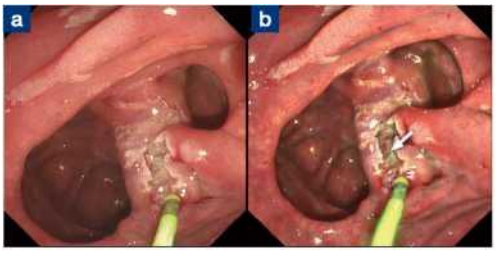

Fig. 12: Precut case
a. Performing Precut after bile duct stent placement under WLI, b. TXI Mode 2 emphasizes the irregularities on the post-Precut incision surface, clarifying the bile duct orifice (arrow)

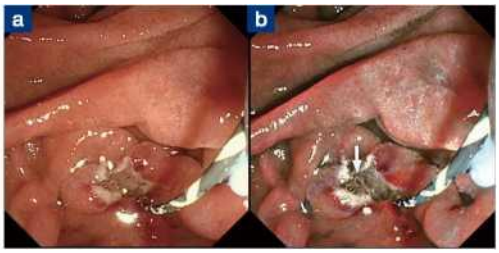

Fig. 13: Precut under challenging conditions with restricted scope position due to cancer at the pancreatic head
a. Performing Precut with the bile duct guide wire in place under WLI, b. TXI Mode 1 emphasizes the bile duct orifice (arrow) for improved visibility

Fig. 13: Recognition of the bile duct orifice on the precut incision surface using TXI Mode 1

3) Biliary-enteric anastomosis/Pancreatico-enteric anastomosis

Narrowing of the biliary-enteric anastomosis/pancreatico-enteric anastomosis associated with cholangitis and pancreatitis has been reported to benefit from balloon endoscopic therapy, but identification of the anastomotic site is often challenging. In cases where the anastomotic site is small or occluded, it is important to identify subtle mucosal structures and changes in color tones. The SIF-H290S allows the use of TXI, which enhances imaging and enables clearer visualization of mucosal structural changes suggesting an anastomotic site. Referring to CT/MRCP, cases where the biliary-enteric anastomosis could not be identified for over 30 minutes using WLI alone were successfully identified using TXI (Fig. 14, Video).[4] Moreover, in cases where the pancreatico-enteric anastomosis was buried in folds and difficult to visualize, TXI enabled clearer visibility (Fig. 15, Video).[4]

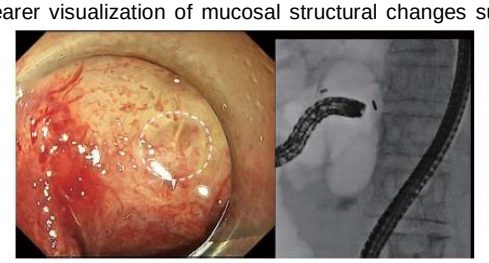

Fig. 14: Biliary-enteric anastomotic stenosis. Inserted with the SIF-H290S, but not visible with WLI despite prolonged exploration. Switching to TXI Mode 2 enabled identification of the anastomotic site (circle)

Fig. 14: Identification of the biliary-enteric anastomosis using TXI Mode 2

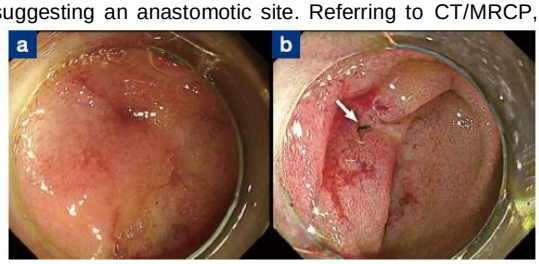

Fig. 15 a.Pancreatico-enteric anastomotic stenosis under WLI, b. Enhanced visibility of the anastomotic site with TXI Mode 1 (arrow)

Fig. 15: Identification of the biliary-enteric anastomosis using TXI Mode 2

4) Recognition of Tumor Boundaries in Duodenal Papilla Tumors

In exposed papillary tumors, predicting malignancy from surface structures, diagnosing the extent of lateral spread, and identifying the bile duct orifice during cannulation are crucial. Additionally, in cases such as intradiverticular papillary tumors or extensive lateral spread, it can be challenging to visualize the extent of lateral spread. TXI enhances imaging, making it easier to evaluate the boundaries and structure of lesions (Fig. 16).[5] Since the spread into the diverticulum was not extensive, and EUS confirmed no invasion into the bile/pancreatic ducts or duodenum, endoscopic papillectomy was performed.

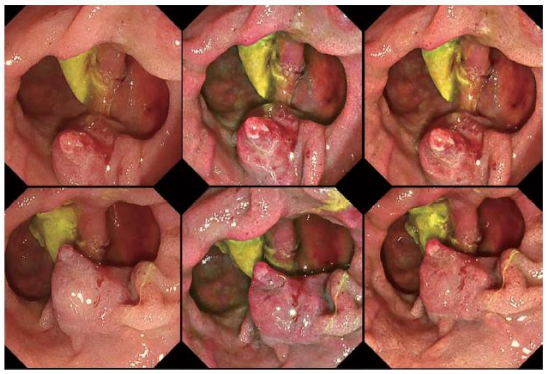

Fig. 16: Papillary tumor in an intradiverticular papilla. TXI provided clearer tumor boundaries. a. WLI, b. TXI Mode 1, c. TXI Mode 2

5 Clinical Applications of RDI

Under WLI, blood appears uniformly red, making it difficult to distinguish between bleeding points and pooled blood. However, with RDI, the contrast between different shades of blood between red and orange makes it easier to identify bleeding points and determine whether bleeding is ongoing. Additionally, reducing the overall redness on the screen decreases the psychological burden on the operator.[1]

1) Identification of Bleeding Points

In post-EST bleeding, visibility is often obscured by pooled blood, but using RDI helps differentiate pooled blood, which appears as light orange, from actively bleeding blood, which appears as dark red. This allows for pinpoint identification of bleeding points, and effective hemostatic treatment can be administered at the same site. (Fig.17, Video)[6]

Furthermore, combining the Gel immersion technique by filling the lumen with gel helps maintain a clear field of view without blood diffusion, facilitating clearer identification of bleeding points. (Fig.18, Video)[7]

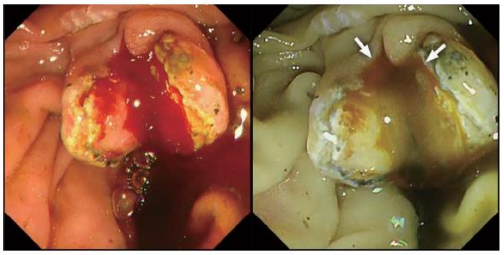

Fig. 17: Identification of bleeding points in post-EST bleeding using RDI.
a. WLI - Bleeding points and pooled blood are recognized as the same red color. b. RDI Mode 2 - Fresh blood is identified as red to orange flow, making identification of bleeding points easier.

Fig. 17: Identification of post-EST bleeding sites using RDI Mode 2

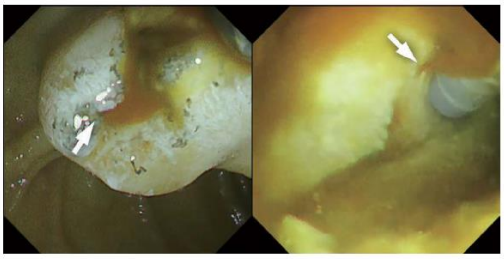

Fig. 18: Identification of bleeding points
a. RDI Mode 2, b. Enhanced clarity of bleeding points with the use of Gel immersion technique

Fig. 18: Identification of post-EST bleeding sites using RDI Mode 2 and the gel immersion method

2) Confirmation of Hemostasis

Sometimes it can be difficult to determine whether "bleeding is ongoing" or if it has stopped with blood components adhering. By using RDI, attention can be focused on whether there is sustained orange-colored flow indicating fresh blood, allowing for determination of the presence of bleeding. With WLI, continuous red fluid leakage suggested ongoing bleeding. However, RDI identified the fluid as brown in color, indicating it was old blood mixed with bile accumulated in the bile duct rather than fresh blood (Fig. 19, Video).[1,6]

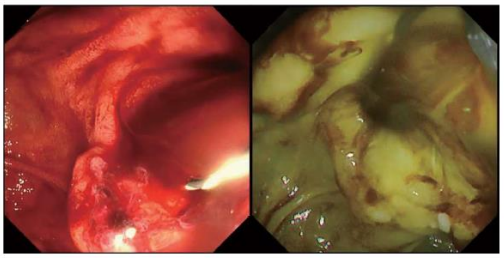

Fig. 19: Evaluation of bleeding presence. a. With WLI, red blood components continue to flow out. b. With RDI, there is no orange-colored liquid flow indicating bleeding, confirming the absence of bleeding.

Fig. 19: Confirmation of hemostasis post-EST bleeding using RDI Mode 2

5 Future of TXI/RDI

This report introduces the features and improvements of the TJF-Q290V along with the utility of TXI and RDI in biliary and pancreatic endoscopic treatment, illustrated with case examples. The TJF-Q290V incorporates various functions and its high performance allows for successful completion of procedures even in challenging cases. As an IEE enhancing visibility during procedures, TXI/RDI has been integrated into EVIS X1, contributing to improved clarity during procedures. TXI is particularly beneficial for beginners in understanding the structure of the duodenal papilla and remains useful for experts during complex cases and precut procedures. RDI has emerged as a specialized IEE that alters color tones to reduce psychological stress and enhance visibility of bleeding points, making it valuable in hemostasis. Future reports are expected to demonstrate its clinical effectiveness, aiming to enhance safety and efficiency in the challenging field of biliary and pancreatic endoscopic therapy, ultimately providing optimal medical care for patients.

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