# LINX® Reflux Management System Safety Profile

The LINX device has been evaluated in numerous clinical studies as well as in a variety of healthcare settings. The device has consistently demonstrated a **low rate of complications** requiring surgical revision, including erosion and migration.

## Erosion

LINX erosion is a rare but important complication that ranges from 0 to 2.0% in published literature (**see Table 2**).[1-10] Erosion, if it occurs, typically occurs within the first four years of implantation.[1,3,8,11] In the longest published patient series to date, Ferrari et al did not see any device erosions in the 124 patients who were greater than 6 years post implant.[1] In the recent publication on the LINX safety profile, the mean time to erosion was 25 months (SD +/- 12.9).[5] Erosion has been found to be related to device size, with the smaller sizes more frequently associated with erosion.[1,3,5] The device is designed to be noncompressive. Chronic pressure on esophageal tissue may increase the risk of erosion, so proper sizing is essential.

## Migration

While there have not been any confirmed device migrations, there have been a few cases reported. It is important to make the distinction between anatomical movement of the gastroesophageal junction (GEJ) anatomy, as is sometimes seen with hiatal hernia recurrence, and device migration. When a hiatal hernia recurs, with movement of esophagus and/or stomach into the chest, the LINX device moves with the surrounding anatomy but may remain where it was surgically placed. For correct placement, create a tunnel between the posterior vagus and the esophagus. Care should be taken to avoid injuring the vagus nerve bundles.

# Revision/Removal

Revisional procedures to remove the LINX device are well-documented. As of November 2021, the published revision rates for LINX ranges from 2.2% to 13%.[1,2,4-13] This range includes Manufacturer and User Facility Device Experience (MAUDE) database analyses as well as single-center experiences with a wide variety of follow up timeframes. This range takes into account a variety of publications reflecting the evolution of patient selection, sizing tools and technique, available sizes, minimal to full dissection and postoperative management.

Although a small percentage of patients may require a revisional procedure to remove the LINX device, device removal does not limit future anti-reflux therapies. A patient can have the LINX device replaced or undergo a fundoplication. Most importantly, a revision can be done as a non-emergent, planned laparoscopic procedure. LINX is one option on the progressive GERD treatment algorithm.

Historically, the most common reasons for revision are persistent dysphagia and recurrent GERD. Table 1 below summarizes the results from DeMarchi et al, the 2021 safety focused publication.[5]

**Table 1:** Most common reasons for device revision and time to revision

| Reason for revision | Number | Percentage of total revisions | Mean time to revision months (+SD) |
|---|---|---|---|
| Dysphagia | 292 | 47.9 | 10.9 (11.9) |
| Persistent GERD | 125 | 20.5 | 20.5 (13.0) |
| Abdominal pain/pain | 46 | 7.6 | 15.8 (14.3) |
| Other/unknown | 68 | 11.2 | 6.8 (6.4) |

# Erosion Management

Patients who experience an erosion typically present with a sudden change in symptoms. Upon further investigation with an upper GI exam, beads are often visible in the esophageal lumen (endoscopic view shown in Figure 1). Generally an erosion can be addressed with a non-emergent, planned intervention. Because the presence of the capsule around the LINX device prevents any food or liquid from moving through the perforation in the esophagus into the abdominal or thoracic cavities, most procedures are non-emergent. In some instances, the device has been removed entirely through an endoscopic procedure. Although there are a variety of methods to remove an eroded device, typically, the device is removed in a two-stage procedure.[4,5,13] The visible beads are removed endoscopically, the esophagus is given 8-12 weeks to heal and then the remaining device is removed laparoscopically.

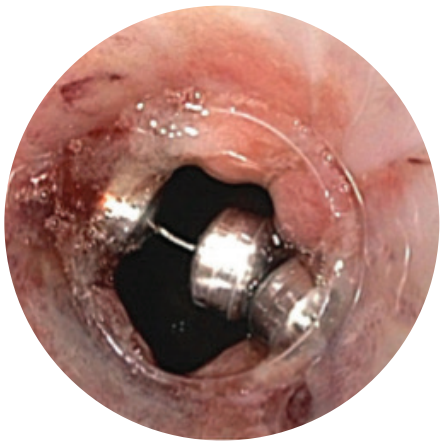

**Figure 1:** Endoscopic view shown

**Table 2:** Published literature reporting LINX erosion rates

| Paper | Retro/ Prospective | Single/ Multi-Center | Follow-up | N= enrolled | Explant rate % | Mean time to explant | Erosion rate % | Comments |
|---|---|---|---|---|---|---|---|---|
| Alicuben 2018 | Retro | Multi | 10-yr period 2007-2017 | 9,453 | NA | Mean time to erosion 26 mos. | 0.3 | Erosion focus, MAUDE, Kaplan-Meier cumulative risk at 4 yrs is 0.3% |
| Bonavina 2013 | Prospective | Single | 5-yr period 2007-2012 | 100 | 3 | 17.3 mos. (range 378-771 days) | 0 | First 100 at this site, some crosssover with pilot patients (Saino 2015) |
| Bonavina 2020 | Prospective | Multi | Completed 3-yr 2009-2014 | 465 | 2.4 | Not stated | 0 | MSA vs. LF OUS registry |
| DeMarchi 2021 | Retro | Multi | 2013-2020 | 27,779 | 2.2 | 14.6 mos. (SD 13.4 mos.) | 0.1 | MAUDE, CHU review, commercially available device only, no 12-bead, Kaplan-Meier cumulative risk for removal is 4.8%, erosion 0.28% at 7 years respectively |
| Ferrari 2020 | Retro | Single | 2007-2020 | 335 | 9.2 | Not stated | 1.8 | Longest published follow-up |
| Ganz 2016 | Prospective | Multi | Completed 5-yr 2009-2014 | 100 | 7 | 18.4 mos. (range 21-1,807 days) | 0 | Pivotal study cohort, long-term |
| LINX post-approval study 5-yr report | Prospective | Multi | 5-yr | 200 | 13 | -- | 2 | -- |
| Lipham 2014 | Retro | Multi | 6-yr period 2007-2013 | 1,048 | 3.4 | Median 3.1 mos. (range 6-1302 days) | 0.1 | MAUDE, includes pilot, pivotal and commercial implants |
| Saino 2015 | Prospective | Multi | Completed 5-yr 2007-2013 | 44 | 6.8 | 22.2 mos. (range 226-1302 days) | 0 | Pilot study cohort, long-term |
| Smith 2017 | Retro | Multi | 4-yr period 2012-2016 | 3,283 | 2.7 | Not stated as overall rate | 0.15 | MAUDE |

## References:


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# LINX® Reflux Management System Important Safety Information

The LINX® Reflux Management System is a laparoscopic, fundic-sparing anti-reflux procedure indicated for patients diagnosed with Gastroesophageal Reflux Disease (GERD) as defined by abnormal pH testing, and who are seeking an alternative to continuous acid suppression therapy (i.e. proton pump inhibitors or equivalent) in the management of their GERD.

**Rx Only.**

**Contraindications:** Do not implant the LINX Reflux Management System in patients with suspected or known allergies to titanium, stainless steel, nickel, or ferrous materials.

**Warnings:** The LINX device is considered MR Conditional in a magnetic resonance imaging (MRI) system up to either 0.7 Tesla (0.7T) or 1.5 Tesla (1.5T), depending on the LINX model implanted. Scanning under different conditions may result in serious injury to you and/or interfere with the magnetic strength and the function of the device. In the event alternative diagnostic procedures cannot be used and MRI is required, the LINX device can be safely removed utilizing a laparoscopic technique that does not compromise the option for traditional anti-reflux procedures. It is recommended that patients receiving the LINX device register their implant with the MedicAlert Foundation (www.medicalert.org) or equivalent organization.

Failure to secure the LINX device properly may result in its subsequent displacement and necessitate a second operation.

Laparoscopic placement of the LINX device is major surgery and death can occur.

**General Precautions:** The LINX device is a long-term implant. Explant (removal) and replacement surgery may be indicated at any time. Management of adverse reactions may include explantation and/or replacement.

The use of the LINX device in patients with a hiatal hernia larger than 3 cm should include hiatal hernia repair to reduce the hernia to less than 3 cm. The LINX device has not been evaluated in patients with an unrepaired hiatal hernia greater than 3 cm.

The safety and effectiveness of the LINX device has not been evaluated in patients with Barrett's esophagus or Grade C or D (LA classification) esophagitis.

The safety and effectiveness of the LINX device has not been evaluated in patients with electrical implants such as pacemakers and defibrillators, or other metallic, abdominal implants.

The safety and effectiveness of the LINX Reflux Management System has not been established for the following conditions:

- Scleroderma
- Suspected or confirmed esophageal or gastric cancer
- Prior esophageal or gastric surgery or endoscopic intervention
- Distal esophageal motility less than 35 mmHg peristaltic amplitude on wet swallows or <70% (propulsive) peristaltic sequences or High Resolution Manometry equivalent, and/or a known motility disorder such as Achalasia, Nutcracker Esophagus, and Diffuse Esophageal Spasm or Hypertensive LES
- Symptoms of dysphagia more than once per week within the last 3 months
- Esophageal stricture or gross esophageal anatomic abnormalities (Schatzki's ring, obstructive lesions, etc.)
- Esophageal or gastric varices
- Lactating, pregnant or plan to become pregnant
- Morbid obesity (BMI >35)
- Age < 21

**Potential Side Effects:** Potential adverse events associated with laparoscopic surgery and anesthesia include adverse reaction to anesthesia (headache, muscle pain, nausea), anaphylaxis (severe allergic reaction), cardiac arrest, death, diarrhea, fever, hypotension (low blood pressure), hypoxemia (low oxygen levels in the blood), infection, myocardial infarction, perforation, pneumonia, pulmonary embolism (blood clot in the lung), respiratory distress, and thrombophlebitis (blood clot). Other risks reported after anti-reflux surgery procedures include bloating, nausea, dysphagia (difficulty swallowing), odynophagia (painful swallowing), retching, and vomiting.

Potential risks associated specifically with the LINX Reflux Management System include achalasia (lower part of esophagus does not relax), bleeding, cough, death, decreased appetite, device erosion, device explant/re-operation, device failure, device migration (device does not appear to be at implant site), diarrhea, dyspepsia (indigestion), dysphagia (difficulty swallowing), early satiety (feeling full after eating a small amount of food), esophageal spasms, esophageal stricture, flatulence, food impaction, globus sensation (sensation of a lump in the throat), hiccups, inability to belch or vomit, increased belching, infection, impaired gastric motility, injury to the esophagus, spleen, or stomach, nausea, odynophagia (painful swallowing), organ damage caused by device migration, pain, peritonitis (inflammation of the peritoneum), pneumothorax (collapsed lung), regurgitation, saliva/mucus build-up, stomach bloating, ulcer, vomiting, weight loss, and worsening of preoperative symptoms (including but not limited to dysphagia or heartburn).



ETHICON

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