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XXIX IFSO World Congress

1-4 September 2026 | Toronto, Canada

Perioperative Complications of Bariatric and Metabolic Surgery: Risk Analysis and Prevention

TORONTO2026

The Future of Obesity Management:
From Weight Loss to Health Gain

Speaker: Weihua Yu | Institution: Sir Run Run Shaw Hospital

ifso2026.org

Disclosure Slide

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	No, nothing to disclose
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Example: company XYZ	x		x		x			

OUTLINE

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Presentation Framework

References: All data are cited with references; full citations available in the reference pages (58 references total).

01 Landscape & Baseline

Global surgical volume and procedure mix; overall perioperative mortality and complications

Mortality 0.3% • SG 57% *IFSO · LABS · MBSAQIP*

02 Risk Identification & Stratification

OS-MRS mortality risk score; modifiable and non-modifiable risk factors

5 factors 3 tiers • 0.2%→2.4% *DeMaria 2007 · Osti 2024*

03 Core Complications

Anastomotic/staple-line leak · Postoperative bleeding · VTE · Marginal ulcer

Leak 0.17% • MU 0.6-25% *MBSAQIP · Cochrane · Meta*

04 Prevention System

Technical details · ERAS pathway · Platform selection · QI closed loop

ERAS -1.5d • Robot +2.4/1000 *ERAS Society · JACS 2026*

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Global Bariatric & Metabolic Surgery: Volume and Procedure Mix

593,500

Global registered bariatric procedures in 2023 [1]

57%

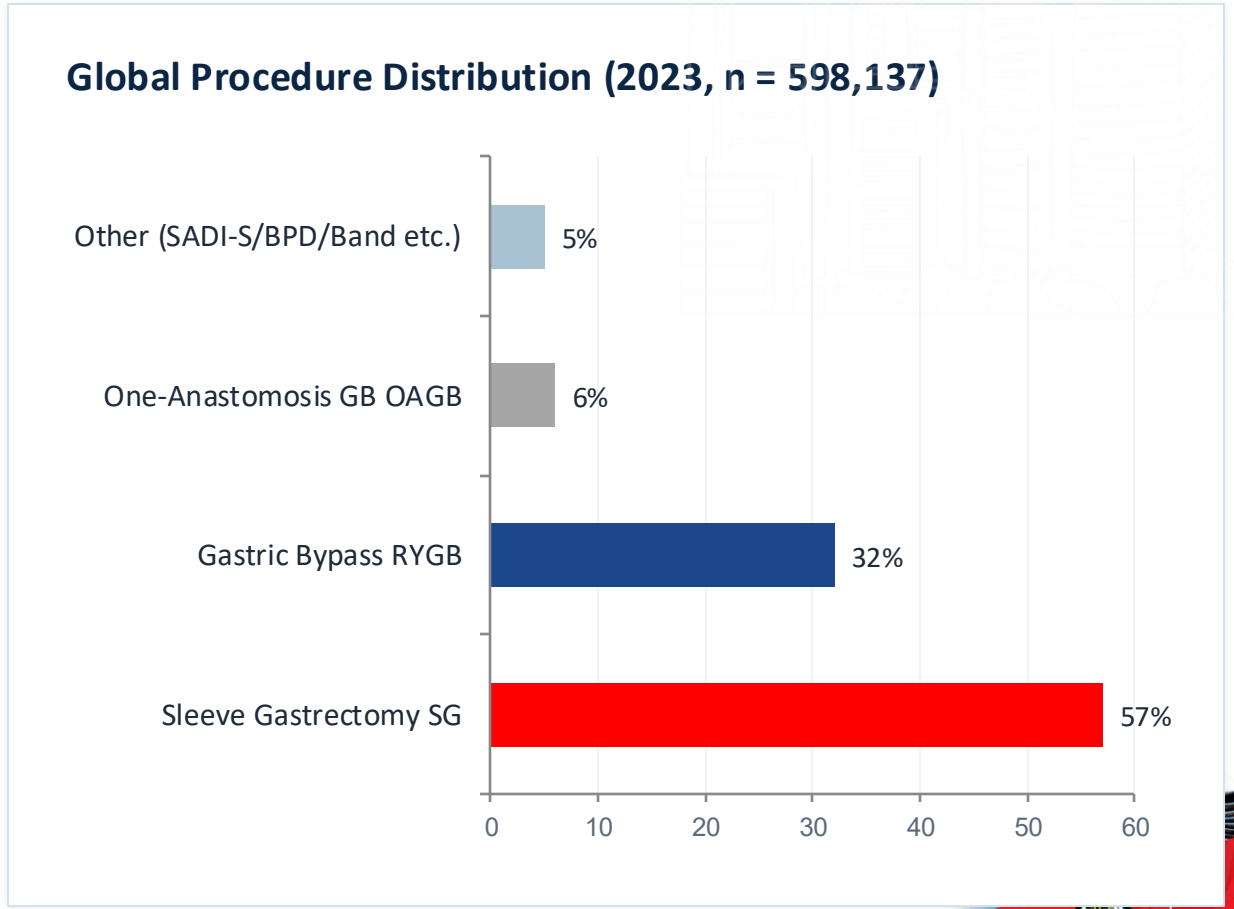
Sleeve Gastrectomy (SG) share of global procedures [1]

United States data (2022)

LSG 160,600 cases | RYGB 62,097 cases

SG and RYGB together account for ~92% of global volume

(8th IFSO report covers 26 registries, 502,150 cases)



References: [1] IFSO 9th Global Registry Report; [2] Emerg Med Clin North Am. 2024; [29] Brown WA, et al. Obes Surg. 2024.

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Perioperative Safety Baseline: Low Mortality, but the Complication Spectrum Matters

0.3%

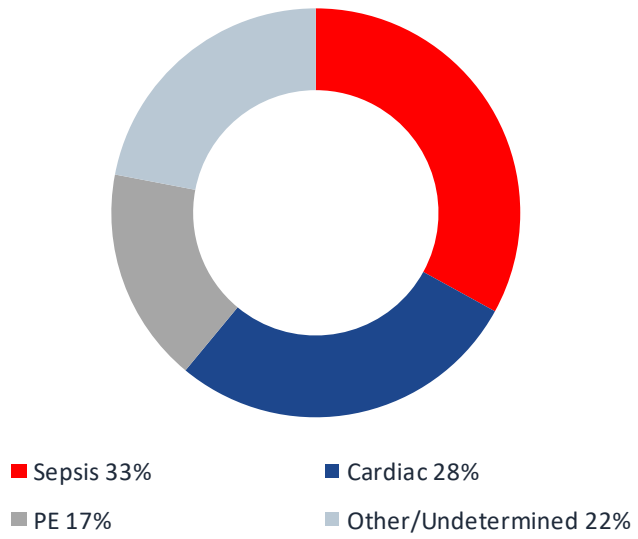
30-day all-cause mortality
LABS prospective cohort, n = 6,118 [3]

30-day overall complication rate

LSG 5.8% vs RYGB 8.0%

Adolescent MBSAQIP cohort: severe complications 1.44%, 30-day mortality 0 [5]

30-day Causes of Death (LABS independently adjudicated, 18 deaths) [3]



Sepsis (secondary to leak) is the leading cause; leak, cardiac events, and PE together account for the majority of deaths [3]

Clinical Interpretation

- 30-day mortality 0.3%, on the same order as laparoscopic cholecystectomy [3,4]
- RYGB composite endpoint rate 4.8% [4]
- Complications follow a 'low probability x high severity' distribution — a single leak or PE can be fatal
- Procedure choice is a risk decision: LSG complication rate significantly lower than RYGB [2,5]

References: [3] Smith MD, et al. Obes Surg. 2011. PMID: 21866378; [4] Flum DR, et al. N Engl J Med. 2009; [5] [2] Adolescent cohort and review data.

Perioperative Complication Spectrum: Incidence, Timing, and Key Risk Factors

Complication	Representative Incidence	Peak Timing	Key Risk Factors	Ref.
Anastomotic/staple-line leak	0.17%-2.4% (significant decline over time)	POD 3-7 peak	HTN · GERD · Smoking · Low albumin · Op time	[6,7,8]
Postoperative bleeding (LSG staple line)	0.2%-0.3% (large registry data)	POD 0-72 h	Anticoagulants · SLR method · Staple cartridge selection	[17]
VTE (DVT/PE)	0.3%-2.2%; PE ~0.5%-1%	Intraop to POD 30	Prior VTE · High BMI · Immobility · OCP	[9,18]
Marginal ulcer (RYGB)	0.6%-25%	POD 3-12 months	Smoking · Glucocorticoids · DM · NSAIDs · H. pylori	[10,21]
Internal hernia / SBO (RYGB)	Unclosed mesenteric defect is primary factor	Late onset, can present acutely	Unclosed defect · Significant weight loss	[2]
Early dumping syndrome	Up to 40% (mostly mild)	Within weeks postop	Hyperosmolar food intake · Rapid gastric emptying	[2]
Postoperative cholelithiasis	6%-12%	Within 6 months postop	Rapid weight loss · Biliary stasis	[2]

All complications graded using the Clavien-Dindo classification [27]; 'Perioperative' focuses on 30 days, but prevention of late complications must begin intraoperatively.

References: [6] [7] [8] [9] [10] [17] [18] [21] [27] [2] See reference pages for full citations.

Preoperative Risk Stratification: OS-MRS Mortality Risk Score

5 preoperative variables, 1 point each (0-5) [11]

01 **BMI >= 50 kg/m2** OR 3.60 (95%CI 1.44-8.99)

02 **Male sex** OR 2.80 (95%CI 1.32-5.92)

03 **Hypertension** OR 2.78 (95%CI 1.11-7.00)

04 **PE risk factors (prior VTE / RHF / hypoventilation)**
OR 2.62 (95%CI 1.12-6.12)

05 **Age >= 45 years** OR 1.64 (95%CI 0.78-3.48)

Risk Classification and 90-day Mortality (Multicenter Validation Cohort, n = 4,431) [12]

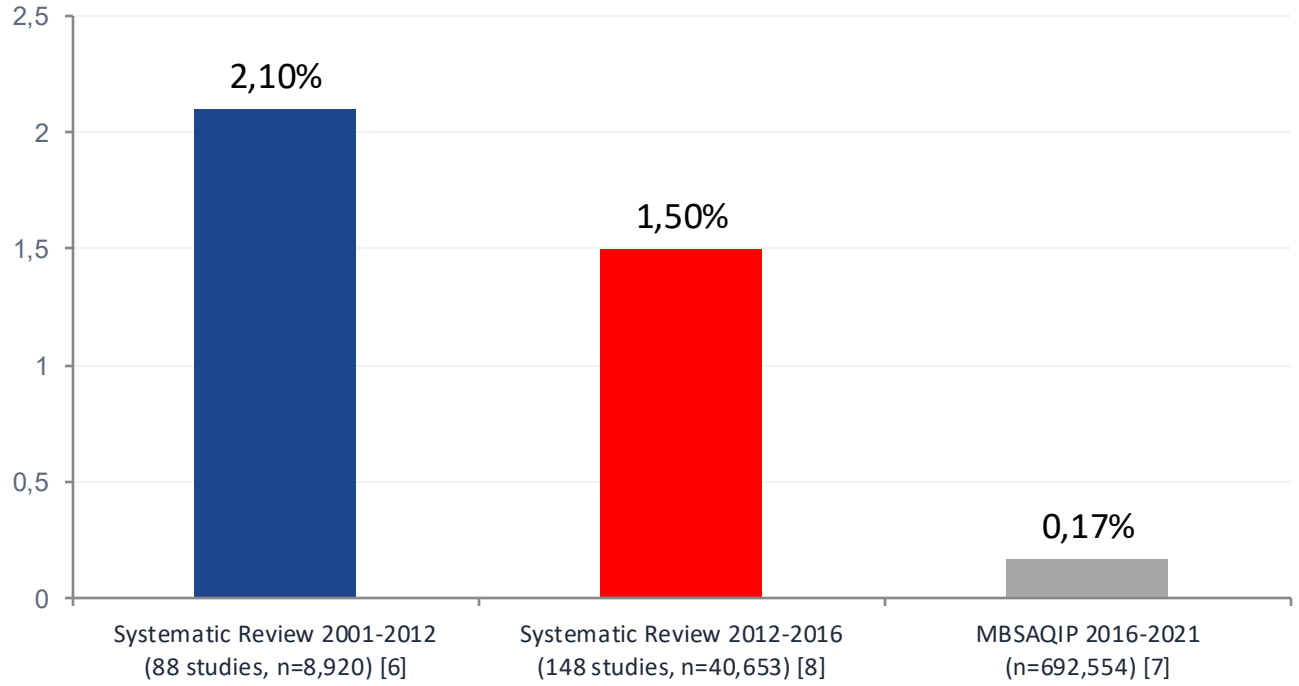
Class	Score	90-day Mortality	Initial Cohort [11]
A (Low)	0-1	0.2%	0.31%
B (Intermediate)	2-3	1.1%	1.90%
C (High)	4-5	2.4%	7.56%

Clinical application: Class C patients comprise only 3% of the cohort but account for 9% of deaths [12] — refer to high-volume centers

References: [11] DeMaria EJ, et al. Surg Obes Relat Dis. 2007; [12] DeMaria EJ, et al. Ann Surg. 2007. PMID: 17893494.

Anastomotic / Staple-Line Leak: Historical Trends in Incidence

LSG Staple-Line Leak Rate: From Early Experience to Large-Registry Era



30-day Leak Rate by Procedure

- LSG: 0.17% (MBSAQIP, n=692,554) [7]
- BPD/DS: 0.8%, ~2x RYGB (0.4%) [13]
- OAGB: 1%, 62.1% require reoperation [58]

Trend Interpretation

- Leak risk in 2020-2021 decreased vs. 2016-2019 (OR 0.69, P<0.01) [7]
- Decline attributed to technical standardization, device improvements, and learning curve maturation

References: [6] Gagner M, et al. Surg Endosc. 2014. PMID: 24745978; [7] Osti NB, et al. Surg Endosc. 2024. PMID: 39218833; [8] [13] [58] Systematic reviews and large-sample analyses.

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Staple-Line Leak Risk Factors: MBSAQIP Data from 692,554 Cases

MBSAQIP 2016-2021, 692,554 primary SG, multivariable logistic regression [7]

Hypertension

Independent risk factor

Preoperative BP optimization should be integrated into pathway

GERD

Independent risk factor

Preoperative endoscopic evaluation and symptom control

Smoking

Independent risk factor

Smoking cessation >= 4 weeks (ERAS strong recommendation) [22]

Immunosuppression

Independent risk factor

Individualized perioperative medication plan

Albumin < 3.5 g/dL

Independent risk factor

Preoperative nutritional assessment and correction

Prolonged operative time

Independent risk factor

Senior surgeons should lead difficult cases

Additional findings: General surgeons performing robotic SG had 2.2x the leak risk of specialists (OR 2.2, P=0.02) [7]; leaks predominate at the EGJ — the thinnest gastric wall with highest tension [14,57]

References: [7] Osti NB, et al. Surg Endosc. 2024. PMID: 39218833; [14] Rosenthal RJ, et al. Surg Obes Relat Dis. 2012. PMID: 22248433; [22] [57] ERAS and multicenter data.

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Leak Prevention (1): Bougie Calibration

Parikh 2013 — Ann Surg
Meta-analysis, 112 studies, n = 8,922 LSG [33]

- 198 leaks occurred postoperatively (2.2%)
- **Bougie size >= 40 Fr reduced leak risk by 47%**
- Buttress use did not affect leak incidence
- At 3 years postop, %EWL did not differ between bougie < 40 Fr and >= 40 Fr groups (mean: 70.1%)
- Subsequent studies have repeatedly confirmed that larger bougie does not compromise weight loss outcomes

→ Conclusion: Larger bougie reduces leak risk without compromising weight loss

>= 40 Fr → Leak risk ↓47%, %EWL no difference

Chang 2021 — Sci Rep
Network meta-analysis, 15 studies, n = 2,848 LSG [34]

- Compared four groups: <= 32 Fr, 33-36 Fr, 36-40 Fr, and > 40 Fr
- <= 32 Fr group: Higher EWL but increased leak rate
- **33-36 Fr group: Lowest leak and complication rates, with high EWL**
- 33-36 Fr is the currently optimal recommended range, balancing safety and weight loss

→ Recommended bougie size: 33-36 Fr [34]

33-36 Fr → Optimal balance (low leak + high EWL)

Clinical Takeaway: Bougie size is the only modifiable risk factor for leak. >= 40 Fr reduces leak risk by 47% (Parikh 2013); 33-36 Fr is the optimal balance point (Chang 2021). Larger bougie does not compromise weight loss.

References: [33] Parikh M, et al. Ann Surg. 2013;257(2):231-237. PMID: 23023201; [34] Chang PC, et al. Sci Rep. 2021;11:15217. PMID: 34312476.

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Leak Prevention (2): Staple Cartridge Selection

Chinese Gastric Wall Thickness Data

- Abu-Ghanem 2017 [44]: Gastric wall thickness and stapler selection in LSG, challenging conventional concepts
- Kitaghenda 2023 [45]: Gastric wall thickness measurement in Chinese obese patients after LSG — antrum thicker than Western populations

→ First fire: black or green cartridge; fundus no smaller than blue cartridge [44,45]

- Barski 2018 [46]: Literature review on gastric wall thickness, emphasizing importance of individualized cartridge selection
- Significant individual variation in gastric wall thickness; intraoperative palpation is the most direct assessment

International SG Expert Panel Consensus [14]

Rosenthal 2012 — Based on >12,000 cases [14]

- **Staple height < 1.5 mm (blue cartridge) should NOT be used for LSG**
- **Antrum stapler height should be no less than 2 mm (green cartridge)**
- Cartridge-gastric wall mismatch is a mechanical cause of leak and bleeding
- Cartridge selection and staple-line reinforcement are complementary strategies; they cannot replace each other

→ Core principle: Cartridge selection must match gastric wall thickness; Chinese patients require special attention to antrum thickness [14,44,45]

antrum >= green

Clinical Takeaway: Cartridge matching to gastric wall thickness is the fundamental principle for preventing leak and bleeding. Chinese patients have thicker antrum than Western populations, requiring individualized selection. Blue cartridge not recommended for LSG; antrum should use >= green cartridge [14,44,45].

References: [44] Abu-Ghanem Y, et al. Obes Surg. 2017. PMID: 28035523; [45] Kitaghenda FK, et al. Updates Surg. 2023. PMID: 37258849; [46] [14] Literature review & international consensus.

Leak Prevention (3): Staple Line Reinforcement (SLR) — Meta-Analysis Evidence

Choi 2012 — Obes Surg Meta-analysis, 8 studies, n = 1,345 LSG [35]

- **SLR reduced leak incidence by 55%**
- Buttress reinforcement: 56% leak reduction
- Suture reinforcement: 68% leak reduction
- Buttress + suture combined: 49% leak reduction
- All included studies were observational; evidence level limited
- Suture reinforcement may be most effective due to simultaneous tension reduction

→ Suture reinforcement most effective for leak reduction

Wang 2016 — Int J Surg RCT meta-analysis, 8 studies, n = 791 LSG [47]

- **SLR reduced leak incidence by 35%**
- Buttress reinforcement: 47% leak reduction
- Suture reinforcement: 25% leak reduction
- RCT evidence level is higher than observational studies; results more reliable
- The discrepancy between two meta-analyses suggests study design significantly affects conclusions

→ Unlike Choi: This meta included only RCTs; buttress outperformed suture reinforcement

Clinical Takeaway: Meta-analyses suggest SLR may reduce leak rate, but observational and RCT evidence conclusions are inconsistent. RCT meta-analysis shows buttress is superior; observational meta-analysis shows suture is superior. Large-registry data must be considered for comprehensive judgment.

References: [35] Choi YY, et al. Obes Surg. 2012. PMID: 22661018; [47] Wang Z, et al. Int J Surg. 2016. PMID: 26700201.

Leak Prevention (4): SLR — MBSAQIP Large-Sample Evidence

Berger 2016 — Ann Surg

MBSAQIP 2012-2014, n = 189,477 primary LSG [36]

- No reinforcement (22%): leak rate 0.65%
- Buttress group (48.4%): leak rate 0.96%
- Suture group (11%): leak rate 0.59%
- Buttress + suture combined (18.6%): leak rate 1.22%
- Selection bias may explain higher leak rates in buttress group — high-risk patients more likely to receive reinforcement

→ Buttress and combined groups had higher leak rates than suture and no-reinforcement groups

Demeusy 2018 — SOARD

MBSAQIP 2015-2016, n = 198,339 primary LSG [48]

- No reinforcement (23.0%), buttress (54.2%), suture (9.5%), buttress + suture (13.3%)
- **No statistically significant difference in postoperative leak or overall complications among the four groups**
- MBSAQIP has the largest sample size and strongest representativeness, but lacks randomization
- Large-registry data conclusions should serve as the primary reference for clinical decision-making

→ Large-registry data do not support SLR reducing leak rate

Clinical Takeaway: MBSAQIP large-sample data (~400,000 cases) does not support SLR reducing leak rate. Positive conclusions from meta-analyses may be affected by selection bias and publication bias. Large-registry data carry higher evidence level.

References: [36] Berger ER, et al. Ann Surg. 2016. PMID: 27433904; [48] Demeusy A, et al. SOARD. 2018. PMID: 30098885.

Leak Prevention (5): SLR — Latest Large-Sample Data

Highet 2023 — Ann Surg

MBSAQIP 2012-2018, n ~ 340,000 LSG [30]

- **Buttress reinforcement reduces minor bleeding after LSG**
- Minor bleeding OR 0.78 (P<0.01)
- But does not reduce severe bleeding
- **No effect on gastrointestinal leak incidence**

→ SLR benefit is primarily in bleeding prevention, not leak prevention

Clinical Takeaway: Cumulative ~850,000 MBSAQIP cases consistently show SLR does not reduce leak rate but clearly reduces bleeding rate (especially minor bleeding). The evidence-based benefit of SLR should be positioned in bleeding prevention.

Aboueisha 2023 — Surg Endosc

5-year propensity-matched analysis, n ~ 513,000 LSG [31]

- **Buttress reinforcement vs. no reinforcement: no difference in LSG postoperative leak (0.4% in both) [31]**
- But reduces overall bleeding and major bleeding rates (p < 0.001)
- 513,000-case data provides the strongest evidence that SLR does not affect leak rate
- SLR's bleeding reduction benefit is consistent and significant (P<0.001)

→ 513,000-case data: SLR does not affect leak rate but reduces bleeding

References: [30] Highet A, et al. Ann Surg. 2023;277(1):121-126. PMID: 34029226;
[31] Aboueisha MA, et al. Surg Endosc. 2023. PMID: 35927350.

Leak Prevention (6): Fibrin Sealant and Routine Drainage

Fibrin Sealant

Chen 2021 — Obes Surg, 9 RCTs, n = 2,136 [49]

- **Fibrin sealant reduces postoperative bleeding**
- **But does not reduce postoperative gastric leak**
- Compared with suture reinforcement, reduces operative time
- No significant difference in reducing postoperative bleeding or leak vs. suture reinforcement
- Fibrin sealant may reduce operative time but increases material cost

Routine Drainage

Albanopoulos 2011 — n = 353 [50]; Doumouras 2017 — n = 142,631 [38]

- Albanopoulos: Routine drain group leak 4% vs. no drain 2.6%, not statistically significant
- **Doumouras: Routine LSG drainage increased leak rate by 35%, statistically significant**
- Chinese consensus (2022): Do not routinely place drains (consensus rate 83.2%) [43]
- Drain-related complications may include drain-associated infection
- Selective drain placement only for abnormal intraoperative findings

→ Routine drainage is not recommended

Clinical Takeaway: Fibrin sealant does not reduce leak rate; routine drainage may even increase leak risk. International and Chinese guidelines agree: do not routinely place drains. Drain placement after LSG should be individualized based on intraoperative findings.

References: [49] Chen YS, et al. Obes Surg. 2021. PMID: 33145716; [50] Albanopoulos K, et al. Obes Surg. 2011. PMID: 21181290; [38] [43] Doumouras 2017. PMID: 29079385 & Chinese Consensus 2022.

Leak Prevention (7): Intraoperative Leak Test and Postoperative UGI

Intraoperative Leak Test (IOLT)

Yolsuriyanwong 2019 [37] + Jung 2022 [51]

- Yolsuriyanwong: MBSAQIP n=265,309, 81.9% had IOLT; no difference in postoperative leak rate whether tested or not
- Jung: MBSAQIP n=363,042, primary/revisional SG/RYGB four groups; no difference in leak rate with or without IOLT
- IOLT positive rate is low (<1%); negative results cannot rule out postoperative leak
- No unified recommendation for methylene blue vs. air leak test
- **But IOLT may reduce postoperative bleeding rate (Jung 2022)**

→ Not routinely recommended; may be used selectively

Clinical Takeaway: Neither IOLT nor postoperative UGI can effectively predict or diagnose postoperative leak. Clinical signs (fever, tachycardia, abdominal pain) are more reliable warning indicators. Both are optional, not routinely recommended.

Postoperative Upper GI Series

Chivot 2017 [52] + Sethi 2016 [53]

- Chivot: n=1,137 LSG with routine UGI; leak 2.6%, mean diagnosis at POD 23.4, limited value
- Sethi: n=1,762 LSG with routine UGI; most patients with leak had normal early postoperative UGI
- **Fever, abdominal pain, and inflammatory markers better predict leak**
- Postoperative UGI false-negative rate up to 60%; limited value for early leak diagnosis
- Clinical signs (fever, abdominal pain, tachycardia) are more reliable than UGI

→ Routine UGI is not recommended

References: [37] Yolsuriyanwong K, et al. 2019. PMID: 31474524; [51] Jung JJ, et al. 2022. PMID: 33475846; [52] Chivot C, et al. 2017. PMID: 28330791; [53] Sethi M, et al. 2016. PMID: 26416376.

Leak Prevention (8): Comprehensive Strategy and Core Principles

Preoperative Optimization

Correct hypoalbuminemia (albumin < 3.5 g/dL is an independent risk factor [7]), hyperglycemia, hypertension, severe OSAHS

→ **Mandatory preop**

Postoperative Diet

Transitional diet; prevent premature or excessive intake of semi-liquid/solid food; elevated intraluminal pressure is a mechanical leak trigger

→ **Strict stepwise advancement**

His Angle Dissection

Avoid excessive mobilization of the proximal posterior gastric wall and His angle; preserve blood supply at the gastric fundus remnant [14]

→ **Core principle**

Technical Priority

Properly His angle dissection, avoid fundal remnant and proximal stenosis — more important than choice of reinforcement material [14,57]

→ **Core principle**

Gagner 2020 Review

Leak rates across 5 reinforcement options: APM absorbable membrane (0.7%) lowest, bovine pericardium (2.7%) highest [8]

→ **Reference evidence**

Chinese Consensus (2022)

Absorbable running seromuscular / full-thickness suture reinforcement of staple line reduces delayed bleeding and leak (consensus rate 94%) [43]

→ **Strong recommendation**

References: [7] Osti NB, et al. 2024. PMID: 39218833; [14] Rosenthal RJ, et al. 2012. PMID: 22248433; [57] [8] [43] Multicenter data & consensus.

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Leak Classification and Stepwise Management

Acute leak < 7 days
Primarily technique-related

→

Early leak 1-6 weeks
Ischemia / poor healing

→

Late leak > 6 weeks
Tendency toward chronicity

→

Chronic leak > 12 weeks
Rarely self-healing [14]

International SG Expert Panel Consensus Classification [14]

① Assess Stability

Septic shock / diffuse peritonitis

→ Emergency laparoscopic exploration, irrigation and drainage [14,16]

Hemodynamically stable

→ CT-guided drainage or conservative management (NPO/TPN/PPI/antibiotics) [16]

② Endoscopic Stepwise Therapy

- Covered stent: indicated for proximal acute/early leak [16]
- Stent migration rate 15%-60%
- OTSC, endoscopic clips, bio-glue for small fistulae
- EVT clinical success rate 87.2% [15]

③ Definitive Surgery for Chronic Leak

- Conservative treatment > 3 months without healing = chronic leak [16]
- Roux-en-Y jejunal limb overlay or diversion
- Reoperation timing: >= 12 weeks [14]

References: [14] Rosenthal RJ, et al. Surg Obes Relat Dis. 2012. PMID: 22248433; [15] [16] Endoscopic treatment evidence.

03 · Core Complication: Bleeding

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Postoperative Bleeding (1): SLR Reduces Bleeding — Consistent Evidence

Choi 2012 — Obes Surg

Meta-analysis, n = 1,345 LSG [35]

- **SLR reduced staple-line bleeding by 44%**
- SLR reduced leak incidence by 55%

Berger 2016 — Ann Surg

MBSAQIP 2012-2014, n = 189,477 [36]

- **Reinforced group postop bleeding 0.74% vs. non-reinforced 1.0% (P<0.05)**
- ~80% of surgeons used SLR, 20% did not

Highet 2023 — Ann Surg

MBSAQIP 2012-2018, n ~ 340,000 [30]

- SLR reduces minor bleeding after LSG
- **But does not reduce severe bleeding**

→ SLR bleeding prevention evidence is consistent, but benefit is primarily in minor bleeding

International Consensus：International SG Expert Panel: SLR reduces post-LSG bleeding (100% agreement) [14]

EAES 2020 bariatric surgery guidelines: Recommend SLR in LSG to reduce bleeding (strong recommendation) [41]

Clinical Takeaway: SLR bleeding prevention evidence is consistent (Choi ↓44%, Berger ↓26%, Highet ↓minor bleeding). International consensus and EAES guidelines both give strong recommendations. However, the primary benefit is in minor bleeding; no difference in severe bleeding.

References: [35] Choi YY, et al. Obes Surg. 2012. PMID: 22661018; [36] Berger ER, et al. Ann Surg. 2016. PMID: 27433904; [30] Highet A, et al. 2023. PMID: 34029226; [14] [41] International consensus & EAES guidelines.

Postoperative Bleeding (2): Buttress Reinforcement — Latest Evidence

Shikora 2015 — Obes Surg

Meta-analysis, 295 articles screened, involving 60,000+ patients [54]

- **Both polymer and bovine pericardial buttress reinforcements significantly reduce anastomotic bleeding**
- Bleeding outcome data involved 40,000+ patients
- Jing 2023 [55]: Clinical effectiveness of different matrix reinforcements, further confirming SLR reduces bleeding
- Buttress material selection (polymer vs. bovine pericardium) shows no significant difference in bleeding prevention [54,55]

Aboueisha 2023 — Surg Endosc

5-year propensity-matched, n ~ 513,000 LSG [31]

- **Buttress reinforcement reduces LSG overall and major bleeding rates (p<0.001) [31]**
- EAES 2020: Recommends SLR including buttress reinforcement to reduce LSG bleeding (strong recommendation) [41]
- 513,000-case data provides the strongest evidence for buttress reducing bleeding rate

→ Buttress reinforcement has a clear preventive effect on bleeding

Clinical Takeaway: Buttress reinforcement reduces LSG postoperative bleeding rate with consistent evidence (Shikora, Jing, Aboueisha — three large-sample studies). EAES guidelines strongly recommend. Material selection (polymer vs. bovine pericardium) shows no significant difference.

References: [54] Shikora SA, et al. Obes Surg. 2015. PMID: 25968078; [55] Jing W, et al. Front Bioeng Biotechnol. 2023. PMID: 37351469; [31] Aboueisha MA, et al. 2023. PMID: 35927350; [41] EAES 2020.

Postoperative Bleeding (3): Staple Cartridge Selection

Abu-Ghanem 2017 — Obes Surg

Gastric wall thickness and stapler selection in LSG [44]

- Gastric wall thickness decreases from distal to proximal along the greater curvature
- **Cartridge-wall mismatch → incomplete tissue compression → bleeding**
- Chinese patients have thicker antrum than Western populations → first fire black/green cartridge [44,45]
- International consensus: Staple height < 1.5 mm (blue) not recommended for LSG; antrum >= 2 mm (green) [14]
- Dynamic cartridge adjustment based on actual gastric wall thickness during surgery is best practice

→ Cartridge matching to gastric wall thickness is the fundamental principle for preventing bleeding and leak

Chinese Expert Consensus and Guidelines

Precision Metabolic & Bariatric Surgery Chinese Consensus 2022 [43]; LSG Guidelines 2018 [56]

- LSG Guidelines (2018): Staple line reinforcement reduces delayed postoperative bleeding and leak [56]
- **Chinese Consensus (2022): Absorbable running seromuscular / full-thickness suture reinforcement (consensus 94%, evidence B, strong recommendation) [43]**
- Chinese consensus explicitly recommends suture reinforcement as the preferred method

→ Chinese consensus explicitly recommends suture reinforcement

Clinical Takeaway: Cartridge matching to gastric wall thickness is the fundamental principle for preventing bleeding and leak. Chinese patients have thicker antrum; first fire should use black/green cartridge. Chinese consensus strongly recommends suture reinforcement (consensus rate 94%).

References: [44] Abu-Ghanem Y, et al. Obes Surg. 2017. PMID: 28035523; [45] Kitaghenda FK, et al. 2023. PMID: 37258849; [14] Rosenthal RJ, et al. 2012. PMID: 22248433; [56] [43] Chinese guidelines & consensus.

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Postoperative Bleeding (4): Intraoperative Blood Pressure Control

Karaman 2017 — J Laparoendosc Adv Surg Tech

Relationship between staple-line bleeding and blood pressure [39]

- Mean SBP in patients without staple-line bleeding: 110 mmHg
- Mean SBP in patients with staple-line bleeding: 130 mmHg
- Significant difference between groups
- **SBP > 120 mmHg during gastric transection is an independent risk factor for staple-line bleeding**

→ Maintain intraoperative SBP <= 120 mmHg during transection

- Also reduces the need for hemostatic clips or staple-line suturing

Janik 2017 — Obes Surg

SLEEVE BLEED Prediction Model [40]

- **Preoperative hypertension is an independent risk factor for post-LSG bleeding**
- **Patients without hypertension had 62% lower post-LSG bleeding risk**
- The SLEEVE BLEED model can preoperatively quantify bleeding risk, assisting clinical decision-making

→ Preoperative BP optimization reduces both leak and bleeding risk

Clinical Takeaway: Intraoperative SBP > 120 mmHg is an independent risk factor for staple-line bleeding (Karaman 2017). Preoperative hypertension increases bleeding risk (Janik 2017). Blood pressure optimization is a shared strategy for reducing both bleeding and leak.

References: [39] Karaman K, et al. J Laparoendosc Adv Surg Tech A. 2017. PMID: 28829225; [40] Janik MR, et al. Obes Surg. 2017. PMID: 27730461.

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Postoperative Bleeding (5): Routine Drainage — Not Recommended

Doumouras 2017 — SOARD

MBSAQIP, n = 142,631 bariatric patients, 98,210 LSG [38]

- Routine intra-abdominal drainage after LSG provides no patient benefit
- **Instead, it increases leak, reoperation rate, and all-cause mortality**
- RYGB drainage increased leak risk by 21%, but not statistically significant
- Drain-related complications may include drain-associated infection

→ Routine drainage is not recommended

Chinese Consensus (2022) [43]

Precision Metabolic & Bariatric Surgery Chinese Expert Consensus [43]

- **Do not routinely place drains postoperatively; may place based on intraoperative findings**
- Consensus rate: 83.2% (84/101)
- Evidence level: C
- Recommendation strength: Strong
- Selective drain indications: unsatisfactory intraoperative hemostasis, high-risk anatomic area dissection

→ Chinese and international guidelines agree: no routine drainage

Clinical Takeaway: MBSAQIP 142,000-case data: routine drainage increases LSG postoperative leak and reoperation rates. Chinese consensus (83.2% agreement) aligns with MBSAQIP conclusion: do not routinely place drains.

References: [38] Doumouras AG, et al. SOARD. 2017. PMID: 29079385; [43] Chinese Expert Consensus 2022.

03 · Core Complication: Bleeding

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Postoperative Bleeding (6): Monitoring and Stepwise Management

0.2%-0.3%

LSG 30-day bleeding rate

MBSAQIP 2011-2017 trend stable [17]

Bleeding is one of the most common early LSG complications

(Bleeding > staple-line leak > intra-abdominal abscess); staple line is the primary bleeding source [2]

Risk factors: Anticoagulants, cartridge mismatch, His angle dissection surface [17]

Monitoring and Stepwise Management Strategy

01 **Monitoring** Focus on POD 0-72 h: HR > 120 bpm, SBP drop > 25%, increasing drain output — tachycardia is often the earliest sign [2]

02 **Conservative** Mild bleeding: Volume resuscitation, hemostatic agents, hold anticoagulants; endoscopic hemostasis or angioembolization if needed [17]

03 **Interventional** Endoscopic hemostasis (injection/thermal/clips) or angioembolization for ongoing ooze with hemodynamic stability [17]

04 **Surgical** Hemodynamic instability or >= 2-3 U transfusion: prompt re-exploration — delay is the primary cause of bleeding-related death [2]

References: [17] Xu Q. Chin J Pract Surg. 2019; [2] Emerg Med Clin North Am. 2024.

03 · Core Complication: VTE

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Venous Thromboembolism: The Second Engine of Perioperative Mortality

Incidence (with standard prophylaxis)

0.5%

Weighted PE incidence
19-study meta-analysis [18]

0.3-2.2%

Overall VTE incidence
PE accounts for ~1% [9]

VTE and Mortality

- PE accounts for 17% of 30-day deaths (LABS) [3], and 30%-50% of bariatric surgery-related deaths [20]
- German registry (n=31,668): DVT 0.07%, PE 0.10% with standardized LMWH prophylaxis [20]
- VTE can occur at any time within 30 days postop; post-discharge VTE accounts for 40%-80% of events [9]

Evidence Boundaries of Prevention (Cochrane 2022) [19]

- High-dose vs. standard-dose heparin (4 RCTs, n=597): VTE risk RR 0.55, not significant; major bleeding RR 1.19 [19]
- Weight-adjusted heparin: Major bleeding rises to 2.0%-3.6%, not recommended for routine use [18]
- Current practice: Preoperative LMWH + intermittent pneumatic compression, early postop ambulation [22,23]
- High-risk patients may benefit from extended post-discharge prophylaxis (up to POD 28) [9]
- IVC filters only for patients with anticoagulation contraindications and prior VTE; not routinely recommended [9]

References: [18] Vasc Health Risk Manag. 2012. PMID: 22014482; [9] Bartlett MA, et al. 2015; [19] Cochrane Database Syst Rev. 2022; [20] [3] [22] Registry studies and LABS.

03 · Core Complication: Marginal Ulcer

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RYGB Marginal Ulcer: A Preventable Late Complication

0.6%-25%

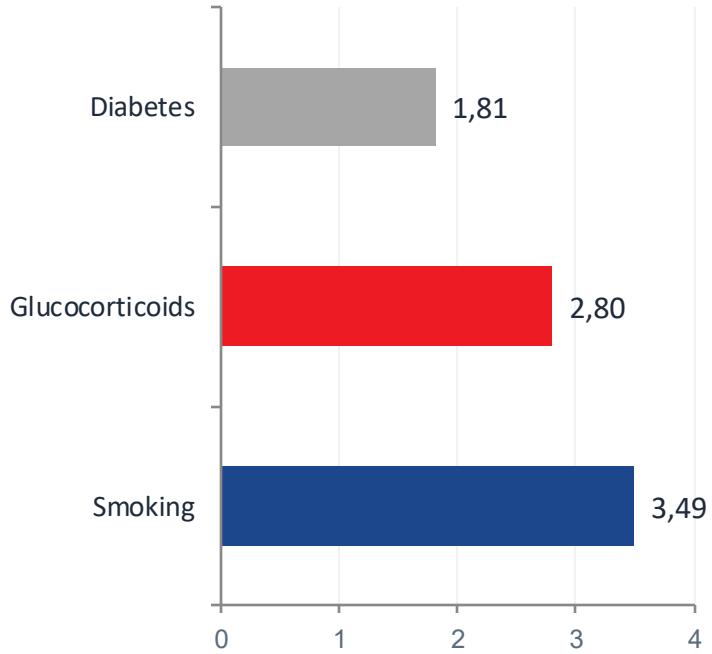
Marginal ulcer incidence

Peak at 3-12 months postop [10]

Prevention Key Points [10]

- Postop PPI >= 3 months (open capsule for faster onset)
- Smoking cessation, discontinue NSAIDs, eradicate H. pylori
- Optimize glycemic control; avoid tension and foreign material at anastomosis

Non-Surgical Risk Factors (Meta, 14 cohorts n=77,250) [21]



Concurrent Concern: Internal Hernia [2]

- Leading cause of SBO after RYGB
- Unclosed mesenteric defects are the most critical risk factor
- **Prevention: Close all mesenteric defects (Peterson space + jejunojejunostomy defect)**
- Significant weight loss enlarges abdominal space, increasing hernia risk
- **Postop abdominal pain + tachycardia = immediate contrast CT**
- CT sensitivity 83%, specificity 87% — first-line imaging modality [2]

References: [21] Liang Y, et al. Int J Surg. 2024; [10] Naseem Z, et al. Am J Gastroenterol. 2026. PMID: 40560186; [2] Emerg Med Clin North Am. 2024.

ERAS Enhanced Recovery Pathway: A Systematic Complication Defense Line

Preoperative

- Smoking cessation >= 4 weeks (ERAS strong recommendation) [22]
- **Clear liquids 2 h / solids 6 h preoperative fasting [22]**
- Low-calorie diet 2-4 weeks to reduce liver volume [23]
- **Prophylactic LMWH + intermittent pneumatic compression [22]**
- Difficult airway and OSA anesthesia assessment [22]
- **Psychological evaluation and compliance education [23]**
- VTE risk stratification determines prophylaxis regimen [9]

Intraoperative

- Antibiotics within 60 min of incision [23]
- **Opioid-sparing multimodal analgesia [22,23]**
- Avoid routine drains and urinary catheters [23]
- **Goal-directed fluid therapy (avoid overloading) [22]**
- Continuous intermittent pneumatic compression [22]
- **IOLT per surgeon preference [23]**
- Control operative time (< 2 h preferred) [7]

Postoperative

- Early ambulation within 6 h postop [23]
- **Clear liquid diet on POD 1 [23]**
- Acetaminophen +/- short-term NSAIDs for analgesia [23]
- **Extended VTE prophylaxis (high-risk to 28 days) [9]**
- Micronutrient education + follow-up [22]
- **Post-discharge phone follow-up + 3-4 weeks clinic visit [23]**
- 30-day complication monitoring and MBSAQIP reporting [1]

Outcome evidence: Italian multi-society consensus — ERABS shortens LOS (median -1.5 days) without increasing major complications, reoperation, or readmission risk [22];

Canadian consensus established 14 core elements [23]; ERAS is a systematic complication defense line — each element reduces a specific risk.

References: [22] Thorell A, et al. World J Surg. 2016; [23] Dang JT, et al. Surg Endosc. 2020; [24] Marinari GM, et al. 2022; [9] Bartlett MA, et al. 2015.

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Robotic Platform: Sobering Evidence Amidst the Technology Craze

MBSAQIP 2020-2024, n = 949,507 [25]

+2.4
Robotic vs. Lap SG
Adjusted excess SAE (per 1,000)

+15.2
Robotic vs. Lap DS/SADI
Adjusted excess SAE (per 1,000)

- After adjustment, robotic-assisted 30-day SAE risk was higher across all procedures [25]
- Mortality was rare and did not differ between platforms [25]
- 8-year MBSAQIP analysis also showed higher robotic SG complication rates [26]
- Robotic platform adds ~$3,000-5,000 per case; no long-term benefit proven to justify it

Three Responses to 'Technology Worship'

01 Platform ≠ Quality

30-day safety is determined by standardized technique, surgeon experience, and center volume — not robotic arms

02 Learning curve is real risk

General surgeons performing robotic SG had 2.2x the leak risk of specialists [7]

03 Value-based decision

The additional cost of the robotic platform must be justified by long-term benefit — current evidence does not support it

References: [25] J Am Coll Surg. 2026. DOI: 10.1097/XCS.0000000000002049; [26] Spurzem GJ, et al. SOARD. 2024; [7] Osti NB, et al. 2024. PMID: 39218833.

04 · Prevention System

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Three-Tier Perioperative Risk Prevention System

Tier 1 · Preoperative

- OS-MRS stratification; Class C referral to high-volume centers [12]
- Smoking cessation >= 4 weeks; optimize BP, glucose, and nutrition [22]
- VTE risk assessment: intensified regimen for prior VTE/hypoventilation [9]
- Low-calorie diet to reduce liver volume, improve operative exposure [23]
- Anticoagulation management: perioperative bridging/hold plan [9]
- OSA assessment and preoperative CPAP compliance [22]

Tier 2 · Intraoperative

- Standardized surgical steps and instrument selection (cartridge matching gastric wall thickness) [17]
- Complete His angle dissection; avoid fundal remnant and stenosis [14]
- RYGB: Close all mesenteric defects [2]
- Senior surgeons lead difficult cases; control operative time [7]
- Standardized safety checklist + conversion-to-open contingency plan [27]

Tier 3 · Postoperative & System

- ERAS pathway: early ambulation and oral intake [22]
- Vigilance mindset: tachycardia/fever/elevated WBC often precede abdominal signs [28]
- MBSAQIP quality closed loop: outcomes data drive process improvement [1]
- Accredited centers + minimum volume standards safeguard outcomes [1]
- 30-day post-discharge phone/clinic follow-up [23]

Clinical Takeaway: Three defense tiers are interlocked: preoperative stratification and optimization (highest cost-effectiveness), intraoperative standardization (directly determines complication rate), postoperative monitoring and systematic quality control (closed-loop improvement). A deficiency in any tier can lead to serious complications.

References: [12] DeMaria EJ, et al. 2007. PMID: 17893494; [22] [9] [23] ERAS guidelines and Cochrane; [17] [14] [2] [7] [27] [28] [1] Integrated from multiple evidence sources.

Key Conclusions

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01 **Safe but not zero-risk** 30-day mortality 0.3%; but a single leak or PE can be fatal [3]

02 **Leak: declining incidence, constant vigilance** LSG leak rate down to 0.17%; sepsis from leak remains the #1 cause of death (33%) [3,7]

03 **Risk prevention starts preoperatively** OS-MRS stratification + modifiable factor optimization is most cost-effective [11,12]

04 **Technical standardization over platform upgrade** Bougie size and cartridge matching affect outcomes more than choice of reinforcement material [33,44]

05 **ERAS and standardization over technology hype** ERAS shortens LOS without increasing complications; robotic surgery does not improve 30-day outcomes [24,25]

06 **Bleeding prevention evidence is clear** SLR reduces bleeding rate with consistent evidence (international consensus 100% agreement), but does not affect leak rate [14,30]

07 **Systems determine outcomes** Accredited centers, volume standards, MBSAQIP data closed loop [1]

(See next page for Key Data at a Glance and References)

Data at a Glance · Key Numbers

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0.3% 30-day mortality (LABS, n=6,118) [3]	**0.17%** LSG staple-line leak rate (MBSAQIP, n=692,554) [7]	**0.5%** PE incidence with standard prophylaxis (Meta, 19 studies) [18]	**0.6-25%** RYGB marginal ulcer incidence [10]
57% Global SG share (IFSO 2023) [1]	**3.49** Smoking OR for marginal ulcer (Meta, n=77,250) [21]	**2.2%** OS-MRS Class C mortality (validation cohort) [12]	**+2.4/1K** Robotic vs. Lap SG excess SAE [25]
↓47% >= 40 Fr Bougie reduces leak risk (Parikh 2013) [33]	**0.2-0.3%** LSG 30-day bleeding rate (MBSAQIP) [17]	**100%** SLR bleeding reduction consensus agreement rate [14]	**↓92%** LSG leak rate from 2.1% to 0.17% (15 years) [6,7]

Thank You · Questions & Discussion | Full references on following pages

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Section Takeaway: Global procedural volume and distribution (IFSO/LABS), OS-MRS mortality risk score (DeMaria 2007), and the spectrum of complications (leak, bleeding, VTE, marginal ulcer) with key supporting evidence.

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Section Takeaway: Evidence on leak and bleeding management (covered stents, EVT, drain strategies), VTE prophylaxis (Cochrane 2022), RYGB marginal ulcer, ERAS pathways (Thorell 2016 / Canadian consensus 2020), and early robotic data.

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Section Takeaway: Three MBSAQIP large-cohort studies on staple-line reinforcement (Berger 2016, Demeusy 2018, Highet 2023, Aboueisha 2023); fibrin sealant, drainage, intraoperative leak testing (IOLT), and upper GI swallow studies.

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Section Takeaway: Gastric wall thickness data (Abu-Ghanem, Kitaghenda in Chinese cohorts, Wang SLR Meta), intraoperative blood pressure control (Karaman/Janik), Chinese expert consensus on bariatric/metabolic surgery (2022), LSG operative guidelines (2018), and latest buttress material evidence.

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