

News Release

Development of New Technology to Detect Postoperative Infections “Quickly and Thoroughly”

–suggesting clinical application potential of Tm mapping method–

Key Points

- Controlling intra-abdominal infections after pancreatic resection remains a significant challenge.
- Traditional bacterial culture and Gram staining tests have limitations in speed and detail.
- The new “Tm mapping” technology estimates the “type and quantity” of causative bacteria in as little as approximately 3 hours.
- We validated its utility in patients following pancreaticoduodenectomy.
- The AUC of the predictive model incorporating Tm mapping was 0.981, suggesting improved quality of postoperative management decisions.

Summary

Pancreatoduodenectomy*¹ (PD) is one of the most demanding gastrointestinal surgical procedures, and postoperative intra-abdominal infection remains a significant challenge. Early detection of intra-abdominal infection and appropriate antibiotic selection directly impact surgical outcomes. Typically, bacterial testing is performed on drainage fluid from the drain*². However, conventional testing methods have limitations: they can only provide a rough classification immediately, and detailed results take time to obtain. This makes it difficult to quickly and accurately determine “whether an infection is likely to occur and what the causative bacteria are” and to reflect this information in postoperative treatment.

Tm mapping is a method that amplifies bacterial DNA in bodily fluids to rapidly estimate the type and quantity of causative bacteria. Results can be obtained in as little as approximately 3 hours, and it can distinguish over 100 types of bacteria. In this study, we evaluated drain fluid after PD surgery using Tm mapping and examined its usefulness.

The results showed that when intra-abdominal infection occurred, the bacterial load measured in the drain fluid by Tm mapping was high. Furthermore, Tm mapping correctly identified bacterial species with approximately 60-80% accuracy. When combining the bacterial load measured by Tm mapping and the appropriateness of antibiotics with routinely used indicators, the predictive accuracy of this comprehensive indicator was 0.981, superior to conventional methods.

Therefore, Tm mapping may offer two advantages for postoperative PD management:

1. Improved accuracy in drain management:

- Continued drain placement for safety if bacterial load is high.
- Earlier drain removal to promote postoperative recovery if bacterial load is low.

2. Appropriate antibiotic use:

- Earlier estimation of bacterial species may enable prompt initiation of targeted therapy, potentially reducing unnecessary antibiotics.

Research Background

Pancreatoduodenectomy (PD) is a major surgery involving pancreatic resection for conditions like pancreatic cancer or biliary tract cancer. Postoperative intra-abdominal infection remains a significant complication. The primary cause is pancreatic fistula^{*3}, but ultimately, the presence and proliferation of bacteria within the abdominal cavity determine the occurrence of intra-abdominal infection. Early detection of infection, along with appropriate antibiotic selection and careful drain management, directly impacts surgical outcomes.

For diagnosing pancreatic fistula, drain fluid amylase (DFA) levels are tested, providing rapid results. Concurrently, bacterial culture of drain fluid is performed to determine if infection is present. Traditional bacterial tests like Gram staining can only provide a broad classification, such as “Gram-positive/negative, cocci/bacilli.” Culturing the drainage fluid can identify the exact bacterial species, but results take several days. This makes it difficult to quickly and accurately determine “whether infection is likely and what the causative bacteria are” and to reflect this in antimicrobial therapy.

Professor Niimi, a member of the research group, possesses a new rapid bacterial testing method called Tm mapping. Tm mapping amplifies bacterial DNA of unknown origin in bodily fluids and compares the melting temperature (Tm value^{*4}) pattern against a dedicated database. This allows for the rapid estimation of bacterial species and bacterial load. Results can be obtained in as little as approximately 3 hours, and it can distinguish over 100 bacterial species. Lead author Haruyoshi Tanaka, Hospital Lecturer, focused on this novel technology and considered its potential application in managing postoperative intra-abdominal infections following gastrointestinal surgery.

Research Results

This study evaluated drain fluid from 42 patients who underwent PD on

postoperative days 1 and 3 using Tm mapping to assess its utility. Patients whose drain management was based on clinical indicators like low DFA levels, indicating no pancreatic fistula, all had bacterial counts exceeding 1,000 CFU^{*5}/mL on postoperative day 3. Thus, Tm mapping showed that bacterial load exceeding 1,000 CFU/mL was a good predictor of intra-abdominal infection development, suggesting Tm mapping could complement routine clinical tests like DFA. Furthermore, Tm mapping correctly identified bacterial species with approximately 60-80% accuracy.

The accuracy (AUC^{*6}) of a comprehensive indicator combining routinely used clinical markers (DFA, white blood cell count, CRP), Tm mapping (bacterial load at POD3), and antimicrobial appropriateness was 0.981, demonstrating superior predictive performance compared to models using clinical markers alone. Based on the above, Tm mapping may offer two advantages for postoperative PD management. (1) Improved drain management accuracy: It can support decisions tailored to the individual's current status; e.g., exercising caution with removal if bacterial load is high despite low DFA, or avoiding excessive prolongation if bacterial load is low. (2) Appropriate antibiotic use: Early estimation of bacterial species may enable prompt initiation of targeted therapy, helping to avoid unnecessary antibiotics.

Research Summary and Future Perspective

This study did not use rapid Tm mapping results to guide postoperative management. Instead, Tm mapping was performed collectively after patients were safely discharged. The appropriateness of the postoperative management at that time was then retrospectively evaluated based on the rapid test results obtained from Tm mapping (this is called a retrospective observational study).

The research group is currently conducting and analyzing a clinical trial to verify how real-time Tm mapping improves postoperative drain management and infection control.

*1. Pancreaticoduodenectomy: A major digestive tract surgical procedure involving the removal of the head of the pancreas, duodenum, bile duct, gallbladder, and part of the stomach.

*2. Drain: A tube placed in the abdominal cavity before the end of surgery and guided outside the body to drain bodily fluids that accumulate in the abdominal cavity postoperatively. If infection occurs, it becomes purulent.

*3. Pancreatic fistula: Refers to pancreatic fluid leaking into the abdominal cavity due to surgical manipulation of the pancreas. Drainage is performed via the tube, and if infection occurs there, antibiotic treatment is necessary.

*4. Tm value: The temperature at which the amplified product of

double-stranded DNA separates (melts) into single strands.

*5. CFU: An abbreviation for Colony Formation Unit. It indicates the number of bacteria when a single colony formed on a culture medium is considered to originate from a single bacterium.

*6. AUC: An abbreviation for Area Under the Curve. It signifies the accuracy of an indicator in predicting outcomes.

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