Analysis of Results and Statistical Explanation of the Study:

Sample Size and Study Design: The study sample consisted of 120 permanent first molars. The study was divided into three sections:

Section 1: The goal is to assess the device's effectiveness in detecting completely healthy teeth, with no evidence of caries, and to differentiate them from teeth showing any signs of caries, whether enamel or dentin.

Study Conditions in Section 1:

- Clinical Value | Laser Value
    -
        - (Presence of caries): 1 or 2 | Greater than 5
    -
        - (Absence of caries): 0 | Less than or equal to 5

Objective: To determine the effectiveness of the device in identifying teeth that are entirely healthy and distinguishing them from teeth with any signs of caries.

Results of Clinical Examination (Section 1):

- 74 teeth were classified as completely healthy with no chalky areas or evidence of mineral loss.
- 26 teeth showed signs of mineral loss with chalky white or brown discoloration but no cavitation.
- 20 teeth exhibited cavitation and structural loss.

Clinical Examination Findings:

- Grade 0: 74 teeth
- Grade 1: 26 teeth
- Grade 2: 20 teeth

Laser Examination Results (Section 1):

- 56 teeth had values greater than 5.
- 64 teeth had values less than or equal to 5.

Detailed Comparison Between Methods:

- Sample | Laser Examination | Clinical Examination
    - 43 teeth | + | + | True Positive
    - 13 teeth | + | - | False Positive
    - 61 teeth | - | - | True Negative
    - 3 teeth | - | + | False Negative

Statistics:

- **Sensitivity:** 4343+3=4346≈93%\frac{43}{43 + 3} = \frac{43}{46} \approx 93\%43+343=4643≈93%
- **Specificity:** 6161+13=6174≈82%\frac{61}{61 + 13} = \frac{61}{74} \approx 82\%61+1361=7461≈82%
- **Accuracy:** 43+6143+13+61+3=104120≈86%\frac{43 + 61}{43 + 13 + 61 + 3} = \frac{104}{120} \approx 86\%43+13+61+343+61=120104≈86%
- **Kappa Value:**

Kappa=Po−Pe1−PeKappa = \frac{P_o - P_e}{1 - P_e}Kappa=1−PePo−Pe

Where:

- Po=43+61120=0.87P_o = \frac{43 + 61}{120} = 0.87Po=12043+61=0.87
- Pe=(46120×56120)+(74120×64120)=0.18+0.33=0.51P_e = \left(\frac{46}{120} \times \frac{56}{120} \right) + \left(\frac{74}{120} \times \frac{64}{120} \right) = 0.18 + 0.33 = 0.51Pe=(12046×12056)+(12074 ×12064)=0.18+0.33=0.51

Kappa=0.87−0.511−0.51=0.360.49≈0.74Kappa = \frac{0.87 - 0.51}{1 - 0.51} = \frac{0.36}{0.49} \approx 0.74Kappa=1−0.510.87−0.51=0.490.36≈0.74

Section 2: The same sample was studied after excluding teeth with laser values indicating carious dentin (95 teeth).

Study Conditions in Section 2:

- Clinical Value | Laser Value
    -
        - (Initial stage caries): 1 | 6 to 14
    -
        - (Absence of caries): 0 | Less than or equal to 5

Objective: To evaluate the device's effectiveness in early caries detection, which is crucial for maintaining the tooth before the caries progress to a stage where conservative treatment is no longer beneficial.

Clinical Examination Results (Section 2):

- 74 teeth were classified as healthy.
- 21 teeth showed early caries signs (chalky white or brown discoloration without cavitation).

Laser Examination Results (Section 2):

- 31 teeth had values between 6 and 14.
- 64 teeth had values less than or equal to 5.

Detailed Comparison Between Methods:

- Sample | Laser Examination | Clinical Examination
    - 18 teeth | + | + | True Positive
    - 13 teeth | + | - | False Positive
    - 61 teeth | - | - | True Negative
    - 3 teeth | - | + | False Negative

Statistics:

- **Sensitivity:** 1818+3=1821≈86%\frac{18}{18 + 3} = \frac{18}{21} \approx 86\%18+318=2118≈86%
- **Specificity:** 6161+13=6174≈82%\frac{61}{61 + 13} = \frac{61}{74} \approx 82\%61+1361=7461≈82%
- **Accuracy:** 18+6195=7995≈83%\frac{18 + 61}{95} = \frac{79}{95} \approx 83\%9518+61=9579≈83%
- **Kappa Value:**

Kappa=Po−Pe1−PeKappa = \frac{P_o - P_e}{1 - P_e}Kappa=1−PePo−Pe

Where:

- Po=18+6195=0.83P_o = \frac{18 + 61}{95} = 0.83Po=9518+61=0.83
- Pe=(2195×3195)+(7495×1395)=0.07+0.52=0.59P_e = \left(\frac{21}{95} \times \frac{31}{95} \right) + \left(\frac{74}{95} \times \frac{13}{95} \right) = 0.07 + 0.52 = 0.59Pe=(9521×9531)+(9574×9513)=0.07+0.52=0.59

Kappa=0.83−0.591−0.59=0.240.41≈0.59Kappa = \frac{0.83 - 0.59}{1 - 0.59} = \frac{0.24}{0.41} \approx 0.59Kappa=1−0.590.83−0.59=0.410.24≈0.59

Section 3:

Clinical Examination Results (Section 3):

- 74 teeth were classified as healthy.
- 26 teeth showed signs of mineral loss.
- 20 teeth exhibited cavitation and structural loss.

Laser Examination Results (Section 3):

- 23 teeth had values greater than or equal to 15.
- 97 teeth had values less than 15.

Detailed Comparison Between Methods:

- Sample | Laser Examination | Clinical Examination
    - 18 teeth | + | + | True Positive
    - 5 teeth | + | - | False Positive
    - 95 teeth | - | - | True Negative
    - 2 teeth | - | + | False Negative

Statistics:

- **Sensitivity:** 1818+2=1820=90%\frac{18}{18 + 2} = \frac{18}{20} = 90\%18+218=2018=90%
- **Specificity:** 9595+5=95100=95%\frac{95}{95 + 5} = \frac{95}{100} = 95\%95+595=10095=95%
- **Accuracy:** 18+95120=113120=94%\frac{18 + 95}{120} = \frac{113}{120} = 94\%12018+95=120113=94%
- **Kappa Value:**

Kappa=Po−Pe1−PeKappa = \frac{P_o - P_e}{1 - P_e}Kappa=1−PePo−Pe

Where:

- Po=18+95120=0.94P_o = \frac{18 + 95}{120} = 0.94Po=12018+95=0.94
- Pe=(20120×23120)+(100120×97120)=0.03+0.67=0.70P_e = \left(\frac{20}{120} \times \frac{23}{120} \right) + \left(\frac{100}{120} \times \frac{97}{120} \right) = 0.03 + 0.67 = 0.70Pe=(12020×12023)+(120100 ×12097)=0.03+0.67=0.70

Kappa=0.94−0.701−0.70=0.240.30≈0.80Kappa = \frac{0.94 - 0.70}{1 - 0.70} = \frac{0.24}{0.30} \approx 0.80Kappa=1−0.700.94−0.70=0.300.24≈0.80

Statistical Comparison:

Range	Sensitivity	Specificity	Accuracy	Kappa
0/5	93%	82%	86%	74%
6/14	86%	82%	83%	59%
15/99	90%	95%	94%	80%