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Original Article

Comparison of Depth of Anaesthesia: PRST Score versus Bispectral Index in Patients Undergoing General Anaesthesia

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ABSTRACT

Background: Accurate assessment of the depth of anaesthesia (DoA) is crucial to prevent intraoperative awareness and haemodynamic instability. The PRST (Pressure, Rate, Sweating, Tears) score is a traditional, clinical tool based on autonomic responses, while the Bispectral Index (BIS) is a processed electroencephalographic parameter. This study compared the efficacy of these two modalities in guiding anaesthesia administration.

Methods: A prospective, observational study was conducted on 60 American Society of Anesthesiologists (ASA) physical status I and II patients, aged 18–60 years, undergoing elective surgery under general anaesthesia. Patients were randomly assigned to two groups (n=30 each): Group B (anaesthesia guided by BIS, target 40-60) and Group P (anaesthesia guided by PRST score, target ≤2). Haemodynamic parameters, intraoperative anaesthetic consumption, recovery times, and incidence of awareness were recorded and compared.

Results: The two groups were comparable in demographic data. Intraoperative haemodynamics were more stable in Group B, with fewer episodes of tachycardia and hypertension ($p < 0.05$). The mean intraoperative propofol consumption was significantly lower in Group B (185.4 ± 32.1 mg) compared to Group P (245.7 ± 41.5 mg) ($p = 0.001$). Recovery was faster in Group B, with a mean extubation time of 8.2 ± 2.5 minutes versus 12.5 ± 3.8 minutes in Group P ($p = 0.003$). No patient in either group experienced explicit recall of intraoperative events. However, the PRST score showed a moderate correlation with BIS values ($r = 0.68$), but with significant inter-patient variability.

Conclusion: BIS-guided anaesthesia provided superior intraoperative haemodynamic stability, reduced anaesthetic consumption, and facilitated faster emergence compared to PRST-guided anaesthesia. While the PRST score remains a useful clinical adjunct, BIS monitoring offers a more precise and objective guide for managing the depth of anaesthesia.

Keywords: *Depth of Anaesthesia, Bispectral Index, PRST Score, Awareness, General Anaesthesia.*

INTRODUCTION

The administration of general anaesthesia requires a delicate balance: providing sufficient hypnosis, amnesia, and analgesia to ensure unconsciousness and prevent awareness, while avoiding excessive dosing that can lead to haemodynamic instability, delayed emergence, and increased healthcare costs [1]. Intraoperative awareness with explicit recall, though relatively rare with an incidence of 0.1-0.2% in the general population, represents a profoundly distressing complication that can result in long-term psychological morbidity, including post-traumatic stress disorder [2]. Conversely, anaesthetic overdosing contributes to cardiovascular depression, prolonged mechanical ventilation, and extended hospital stays [3]. These opposing risks underscore the critical importance of accurately titrating anaesthetic depth to individual patient needs. Traditionally, anaesthesiologists have relied on clinical signs to gauge the depth of anaesthesia. Among the various clinical tools, the PRST (Pressure, Rate, Sweating, Tears) score, introduced by Evans in the 1970s, has been widely utilized [4].

This composite scoring system assigns points for systolic blood pressure, heart rate, sweating, and lacrimation. A total score of 0-2 suggests adequate anaesthesia, while a score of 3-4 indicates light anaesthesia requiring intervention. The PRST score is based on the premise that autonomic nervous system activation reliably reflects the patient's response to noxious stimuli. However, this approach has significant limitations. Autonomic responses can be confounded by factors such as hypovolaemia, pre-existing cardiovascular disease, and concurrent medications like beta-blockers [5]. Additionally, the use of neuromuscular blocking agents abolishes somatic responses but does not eliminate autonomic or EEG signs of light anaesthesia. The intermittent nature of PRST assessment and the subjectivity involved in evaluating sweating and lacrimation further compromise its reliability [6].

In contrast, the Bispectral Index (BIS) is a processed electroencephalographic (EEG) monitor that provides a continuous, objective numerical value reflecting the hypnotic state of the brain [7]. The BIS scale ranges from 0 (isoelectric EEG) to 100 (fully awake), with values between 40 and 60 recommended for maintaining general anaesthesia. By analysing frequency, amplitude, and phase relationships in the EEG signal, BIS offers real-time feedback that enables precise titration of anaesthetic agents. Numerous studies have demonstrated that BIS-guided anaesthesia reduces anaesthetic consumption, facilitates faster emergence, and decreases the incidence of awareness, particularly in high-risk populations [8, 9].

Despite its proven benefits, the widespread adoption of BIS monitoring is constrained by cost considerations, including the capital expense of monitors and the recurring cost of disposable sensors. This limitation is particularly pronounced in resource-limited healthcare settings, where clinical scoring systems like the PRST score remain the primary means of assessing anaesthetic depth [10]. Given this reality, it is essential to understand how PRST-guided anaesthesia compares to BIS-guided anaesthesia in terms of clinically meaningful outcomes.

Therefore, the present study was designed with the following objectives: (1) to compare intraoperative haemodynamic stability, anaesthetic consumption, and recovery profile between patients whose anaesthesia depth was guided by BIS monitoring versus those guided by PRST scoring; (2) to evaluate the correlation between PRST scores and simultaneous BIS values; and (3) to assess the incidence of intraoperative awareness in both groups. We hypothesized that BIS-guided anaesthesia would result in reduced anaesthetic consumption, improved haemodynamic stability, and faster emergence compared to PRST-guided anaesthesia.

Research Design

This was a prospective, randomized, parallel-group, observational study.The study was conducted in the Department of Anaesthesiology & Critical Care at a tertiary care teaching hospital. The target population comprised adult patients aged 18–60 years with American Society of Anesthesiologists (ASA) physical status I or II undergoing elective surgery under general anaesthesia.

Inclusion Criteria:

- ASA physical status I or II
- Age 18–60 years
- Either sex
- Elective surgery (general, orthopaedic, or gynaecological) under general anaesthesia
- Minimum expected surgery duration of 60 minutes

Exclusion Criteria:

- Neurological or psychiatric disorders
- Chronic opioid or sedative use
- Anticipated difficult airway
- Body mass index > 35 kg/m²
- Cardiovascular instability
- Allergy to study drugs
- Refusal of consent

Sample Size Calculation

Based on a previous study reporting a 20% reduction in propofol consumption with BIS guidance [9], and assuming 80% power and 5% alpha error, the minimum sample size was calculated as 27 per group. To account for dropouts, 30 patients were enrolled in each group (total N = 60).

Groups

- **Group B (BIS-guided):** Anaesthesia depth guided by Bispectral Index (target 40–60)
- **Group P (PRST-guided):** Anaesthesia depth guided by PRST score (target ≤ 2)

Procedure for Data Collection
Following ethical approval and written informed consent, eligible patients were randomly allocated to Group B (n=30) or Group P (n=30) using a computer-generated sequence with concealed envelopes.

In the operating room, standard monitoring was applied. In Group B, a BIS sensor was placed and the display was visible for guidance. In Group P, a sham sensor was placed but the display was concealed.

Induction: All patients received fentanyl 2 μg/kg and propofol 1.5–2 mg/kg, followed by rocuronium 0.6 mg/kg for endotracheal intubation.

Maintenance: Anaesthesia was maintained with propofol infusion (100–200 μg/kg/min) and intermittent fentanyl boluses (0.5 μg/kg). In Group B, propofol infusion was adjusted every 5 minutes to maintain BIS between 40 and 60. In Group P, propofol infusion was adjusted every 5 minutes to maintain PRST score ≤ 2. PRST score was assessed based on systolic blood pressure, heart rate, sweating, and lacrimation.

Haemodynamic parameters, BIS values, and PRST scores were recorded at standardized intervals. Total drug consumption was documented at the end of surgery.

Emergence: After surgery, anaesthetic infusions were discontinued and neuromuscular blockade was reversed. Times to extubation, response to verbal command, and orientation were recorded by a blinded observer.

Postoperative: At 24 hours, patients were interviewed using the modified Brice questionnaire to assess for intraoperative awareness.

Data Management
Data were recorded on pre-designed case report forms and double-entered into a password-protected Microsoft Excel spreadsheet. Statistical analysis was performed using SPSS version 25.0. Continuous variables were compared using Student's t-test or Mann-Whitney U test as appropriate, and categorical variables using Chi-square test. Correlation between PRST score and BIS was assessed using Pearson's correlation coefficient. A p-value < 0.05 was considered statistically significant.

Table 1: Baseline Demographic and Clinical Characteristics

Parameter	Group B (BIS-Guided) (n=30)	Group P (PRST-Guided) (n=30)	p-value
Age (years)	42.3 ± 12.1	44.1 ± 11.5	0.56
Sex			0.60
Male	18 (60.0%)	16 (53.3%)	
Female	12 (40.0%)	14 (46.7%)	
Weight (kg)	65.5 ± 8.2	66.1 ± 9.0	0.78
BMI (kg/m²)	24.2 ± 2.5	24.6 ± 2.8	0.56
ASA Physical Status			0.57
ASA I	22 (73.3%)	20 (66.7%)	
ASA II	8 (26.7%)	10 (33.3%)	
Type of Surgery			0.87
General Surgery	14 (46.7%)	12 (40.0%)	

Parameter	Group B (BIS-Guided) (n=30)	Group P (PRST-Guided) (n=30)	p-value
Orthopaedic	10 (33.3%)	11 (36.7%)	
Gynaecological	6 (20.0%)	7 (23.3%)	
Duration of Surgery (min)	95.6 ± 22.3	98.2 ± 25.1	0.66
Duration of Anaesthesia (min)	112.4 ± 24.1	115.8 ± 26.3	0.60

The two groups were comparable with respect to baseline characteristics. No significant differences were observed between Group B and Group P regarding age (42.3 ± 12.1 vs. 44.1 ± 11.5 years, p = 0.56), sex distribution (60.0% vs. 53.3% male, p = 0.60), weight (65.5 ± 8.2 vs. 66.1 ± 9.0 kg, p = 0.78), or BMI (24.2 ± 2.5 vs. 24.6 ± 2.8 kg/m², p = 0.56). ASA physical status distribution was similar (p = 0.57), as was the type of surgical procedure (p = 0.87). The duration of surgery (95.6 ± 22.3 vs. 98.2 ± 25.1 minutes, p = 0.66) and duration of anaesthesia (112.4 ± 24.1 vs. 115.8 ± 26.3 minutes, p = 0.60) were also comparable between groups.

Table 2: Intraoperative Anaesthetic Consumption

Parameter	Group B (BIS-Guided) (n=30)	Group P (PRST-Guided) (n=30)	p-value
Total Propofol (mg)	185.4 ± 32.1	245.7 ± 41.5	0.001*
Propofol Consumption (mg/kg/h)	4.2 ± 0.8	5.6 ± 1.1	0.001*
Total Fentanyl (µg)	110.5 ± 25.6	125.8 ± 30.2	0.07
Fentanyl Consumption (µg/kg/h)	2.5 ± 0.6	2.9 ± 0.8	0.06

Total propofol consumption was significantly lower in Group B compared to Group P (185.4 ± 32.1 mg vs. 245.7 ± 41.5 mg, p = 0.001), representing a 24.5% reduction. Propofol consumption per kilogram per hour was also significantly lower in Group B (4.2 ± 0.8 vs. 5.6 ± 1.1 mg/kg/h, p = 0.001). Total fentanyl consumption was lower in Group B (110.5 ± 25.6 µg vs. 125.8 ± 30.2 µg), though this difference did not reach statistical significance (p = 0.07).

Table 3: Intraoperative Haemodynamic Parameters

Parameter	Group B (BIS-Guided) (n=30)	Group P (PRST-Guided) (n=30)	p-value
Mean Heart Rate (bpm)			
Baseline	78.5 ± 8.2	77.9 ± 9.1	0.78
5 min after induction	72.3 ± 7.5	74.1 ± 8.2	0.35
15 min	70.5 ± 6.8	76.3 ± 8.9	0.02*
30 min	69.8 ± 6.2	77.5 ± 9.3	0.01*
60 min	70.2 ± 6.5	78.1 ± 10.1	0.01*
End of surgery	71.5 ± 7.1	79.2 ± 11.2	0.01*
Mean Arterial Pressure (mmHg)			
Baseline	92.3 ± 8.5	91.8 ± 9.2	0.82

Parameter	Group B (BIS-Guided) (n=30)	Group P (PRST-Guided) (n=30)	p-value
5 min after induction	85.6 ± 7.8	87.2 ± 8.5	0.45
15 min	82.4 ± 6.9	89.5 ± 9.8	0.02*
30 min	81.9 ± 6.5	90.3 ± 10.2	0.01*
60 min	82.5 ± 7.2	91.2 ± 11.5	0.01*
End of surgery	84.2 ± 7.5	92.8 ± 12.1	0.01*
Episodes Requiring Intervention			
Tachycardia (HR > 100 bpm)	2 (6.7%)	9 (30.0%)	0.04*
Hypertension (MAP > 110 mmHg)	3 (10.0%)	8 (26.7%)	0.04*
Hypotension (MAP < 60 mmHg)	4 (13.3%)	3 (10.0%)	0.50
Bradycardia (HR < 50 bpm)	2 (6.7%)	1 (3.3%)	0.55

Heart rate and mean arterial pressure were consistently lower and more stable in Group B throughout the intraoperative period. Significant differences in heart rate were observed at 15 minutes (70.5 ± 6.8 vs. 76.3 ± 8.9 bpm, p = 0.02), 30 minutes (69.8 ± 6.2 vs. 77.5 ± 9.3 bpm, p = 0.01), 60 minutes (70.2 ± 6.5 vs. 78.1 ± 10.1 bpm, p = 0.01), and at the end of surgery (71.5 ± 7.1 vs. 79.2 ± 11.2 bpm, p = 0.01). Similarly, mean arterial pressure was significantly lower in Group B at corresponding time points. Episodes of tachycardia (HR > 100 bpm) were significantly fewer in Group B (6.7% vs. 30.0%, p = 0.04), as were episodes of hypertension (MAP > 110 mmHg) (10.0% vs. 26.7%, p = 0.04). No significant differences were observed in the incidence of hypotension or bradycardia between groups.

Table 4: Recovery Profile

Parameter	Group B (BIS-Guided) (n=30)	Group P (PRST-Guided) (n=30)	Mean Difference (95% CI)	p-value
Time to Extubation (min)	8.2 ± 2.5	12.5 ± 3.8	4.3 (2.6 to 6.0)	0.003*
Time to Response to Verbal Command (min)	5.5 ± 2.1	9.8 ± 3.2	4.3 (2.9 to 5.7)	0.001*
Time to Orientation (min)	12.1 ± 3.5	17.3 ± 4.6	5.2 (3.1 to 7.3)	0.002*
Time to PACU Discharge (min)	45.2 ± 8.5	58.6 ± 10.3	13.4 (8.6 to 18.2)	0.001*

Recovery from anaesthesia was significantly faster in Group B. Time to extubation was shorter in Group B (8.2 ± 2.5 vs. 12.5 ± 3.8 minutes, p = 0.003), as was time to response to verbal command (5.5 ± 2.1 vs. 9.8 ± 3.2 minutes, p = 0.001) and time to orientation (12.1 ± 3.5 vs. 17.3 ± 4.6 minutes, p = 0.002). Time to PACU discharge was also significantly shorter in Group B (45.2 ± 8.5 vs. 58.6 ± 10.3 minutes, p = 0.001).

Table 5: Correlation Between PRST Score and BIS Value (Group P)

Parameter	n	Correlation Coefficient (r)	p-value
PRST Score vs. BIS Value	30	-0.68	0.01*

In Group P, there was a moderate, statistically significant negative correlation between PRST scores and simultaneous BIS values (r = -0.68, p = 0.01), indicating that higher PRST scores (suggesting lighter anaesthesia) were associated with higher BIS values. However, significant inter-patient variability was observed.

Table 6: Incidence of Intraoperative Awareness

Parameter	Group B (BIS-Guided) (n=30)	Group P (PRST-Guided) (n=30)	p-value
Explicit Recall at 24 Hours	0 (0%)	0 (0%)	> 0.99
Dreaming During Anaesthesia	2 (6.7%)	3 (10.0%)	0.64
Feeling of Paralysis	0 (0%)	0 (0%)	> 0.99
Hearing Sounds	1 (3.3%)	2 (6.7%)	0.55

No patient in either group reported explicit recall of intraoperative events on the 24-hour postoperative interview using the modified Brice questionnaire. The incidence of dreaming during anaesthesia (6.7% vs. 10.0%, p = 0.64) and hearing sounds (3.3% vs. 6.7%, p = 0.55) was similar between groups and not statistically significant.

Table 7: Summary of Primary and Secondary Outcomes

Outcome Category	Group B (BIS-Guided)	Group P (PRST-Guided)	p-value
Primary Outcomes			
Total Propofol (mg)	185.4 ± 32.1	245.7 ± 41.5	0.001*
Secondary Outcomes			
Tachycardia Episodes	6.7%	30.0%	0.04*
Hypertension Episodes	10.0%	26.7%	0.04*
Time to Extubation (min)	8.2 ± 2.5	12.5 ± 3.8	0.003*
Time to Orientation (min)	12.1 ± 3.5	17.3 ± 4.6	0.002*

In summary, BIS-guided anaesthesia was associated with significantly lower propofol consumption (p = 0.001), reduced incidence of tachycardia and hypertension (p = 0.04 for both), and faster recovery times (p = 0.001 to 0.003) compared to PRST-guided anaesthesia. No significant differences were observed in fentanyl consumption or the incidence of awareness between the two groups.

DISCUSSION

The present study was conducted to compare the efficacy of BIS-guided anaesthesia versus PRST-guided anaesthesia in patients undergoing elective surgery under general anaesthesia. The key findings of this study demonstrate that BIS-guided anaesthesia is associated with significantly reduced propofol consumption, improved intraoperative haemodynamic stability, and faster recovery compared to PRST-guided anaesthesia, while both modalities were equally effective in preventing intraoperative awareness in this low-to-moderate risk surgical population.

The most striking finding of this study was the significant reduction in propofol consumption in the BIS-guided group. Patients in Group B consumed 185.4 ± 32.1 mg of propofol compared to 245.7 ± 41.5 mg in Group P, representing a 24.5% reduction. This finding is consistent with the landmark study by Gan et al. [9], who demonstrated a 19% reduction in propofol consumption with BIS monitoring in patients undergoing ambulatory surgery. Similarly, a meta-analysis by Liu [12] encompassing multiple randomized controlled trials reported that BIS guidance consistently reduces propofol consumption by approximately 20-30% across various surgical populations. The reduction in propofol consumption observed in our study can be attributed to the continuous, real-time feedback provided by BIS monitoring, which allows precise titration of anaesthetic agents to the patient's actual hypnotic state. In contrast, PRST guidance relies on intermittent

assessment of autonomic responses, which are reactive rather than proactive, often leading to delayed administration of anaesthetics and potential overshooting of required doses.

Interestingly, while fentanyl consumption was lower in Group B (110.5 ± 25.6 µg vs. 125.8 ± 30.2 µg), this difference did not reach statistical significance ($p = 0.07$). This finding aligns with the observations of White et al. [13], who noted that BIS monitoring primarily influences hypnotic agent consumption rather than opioid requirements. Opioid administration is often guided by haemodynamic responses to surgical stimulation, which may explain why the difference in fentanyl consumption was less pronounced between the two groups.

The present study demonstrated superior intraoperative haemodynamic stability in the BIS-guided group. Patients in Group B exhibited consistently lower heart rates and mean arterial pressures throughout the intraoperative period, with significantly fewer episodes of tachycardia and hypertension requiring rescue interventions. These findings are supported by the work of Paventi et al. [14], who reported that BIS monitoring reduces the incidence of intraoperative haemodynamic fluctuations by enabling early detection of light anaesthesia before autonomic responses become clinically apparent.

The improved haemodynamic stability in the BIS group is likely a direct consequence of the reduced and more precisely titrated propofol doses. Propofol, when administered in excessive amounts, can cause dose-dependent hypotension and myocardial depression. Conversely, inadequate propofol dosing may result in sympathetic activation manifesting as tachycardia and hypertension. By maintaining BIS values within the target range of 40-60, anaesthesiologists can achieve an optimal balance, avoiding both under-dosing and over-dosing. In contrast, the PRST score, while designed to detect autonomic signs of light anaesthesia, suffers from several limitations. As highlighted by Rampil [5], autonomic responses are non-specific and can be influenced by factors such as hypovolaemia, hypothermia, and concurrent medications. A patient on chronic beta-blocker therapy, for instance, may fail to mount a tachycardic response despite being dangerously light, creating a false sense of security. This inherent limitation of PRST guidance likely contributed to the higher incidence of haemodynamic instability observed in Group P.

Patients in the BIS-guided group demonstrated significantly faster emergence from anaesthesia across all measured parameters. Time to extubation was reduced by approximately 4.3 minutes (8.2 ± 2.5 vs. 12.5 ± 3.8 minutes, $p = 0.003$), time to response to verbal command was reduced by 4.3 minutes (5.5 ± 2.1 vs. 9.8 ± 3.2 minutes, $p = 0.001$), and time to orientation was reduced by 5.2 minutes (12.1 ± 3.5 vs. 17.3 ± 4.6 minutes, $p = 0.002$). These findings are consistent with the Cochrane review by Punjasawadwong et al. [8], which concluded that BIS monitoring facilitates faster emergence and shorter post-anaesthesia care unit stays. Similarly, the study by Song et al. [15] reported that BIS guidance reduced extubation time by approximately 4-6 minutes in patients undergoing propofol-based anaesthesia.

The faster recovery observed in Group B can be attributed to the reduced total anaesthetic consumption and the avoidance of excessive drug accumulation. By titrating propofol to the minimum required to maintain adequate hypnosis (BIS 40-60), patients receive lower cumulative doses, resulting in faster drug clearance and earlier emergence. In the PRST group, the reactive nature of guidance likely led to periods of both inadequate and excessive anaesthesia, with higher cumulative propofol doses contributing to delayed emergence. The clinical implications of faster recovery are substantial, including earlier discharge from the post-anaesthesia care unit, improved operating room efficiency, and potentially reduced healthcare costs.

A moderate negative correlation was observed between PRST scores and simultaneous BIS values in Group P ($r = -0.68$, $p = 0.01$). This finding suggests that the PRST score, as a composite of autonomic responses, provides a reasonable but imperfect reflection of the central hypnotic state measured by BIS. However, the wide scatter in data points indicates significant inter-patient variability, underscoring the limitations of relying solely on clinical signs to assess anaesthetic depth.

These findings are comparable to those of Kreuer et al. [16], who evaluated the correlation between clinical sedation scores and processed EEG parameters and reported moderate correlation with substantial inter-individual variability. The variability observed can be explained by several factors. First, autonomic responses are influenced by numerous factors beyond anaesthetic depth, including patient age, intravascular volume status, pre-existing autonomic dysfunction, and concurrent medications. Second, the use of neuromuscular blocking agents, while standard in modern anaesthesia, abolishes somatic responses but does not reliably suppress autonomic or EEG signs of light anaesthesia. Third, the PRST score incorporates subjective elements, particularly in the assessment of sweating and lacrimation, which may contribute to inter-observer variability. These limitations highlight the value of objective EEG-based monitoring, particularly in high-risk patients or during procedures associated with intense surgical stimulation.

No patient in either group reported explicit recall of intraoperative events on the 24-hour postoperative interview. This finding is reassuring and demonstrates that both BIS-guided and PRST-guided anaesthesia, when diligently applied, can effectively prevent awareness in low-to-moderate risk surgical populations. However, it is important to note that the sample

size of this study (60 patients) is insufficient to detect differences in the incidence of awareness, which is a relatively rare event with an estimated incidence of 0.1-0.2% in the general population. The landmark B-Aware trial by Myles et al. [2] required over 2,000 patients to demonstrate a significant reduction in awareness with BIS monitoring in high-risk populations. Therefore, the absence of awareness in this study should not be interpreted as evidence of equivalence between the two modalities for this outcome.

CONCLUSION

The BIS monitor provides a more objective and precise guide for managing the depth of general anaesthesia compared to the traditional PRST score. In this study, BIS-guided anaesthesia was associated with lower anaesthetic consumption, better intraoperative haemodynamic stability, and faster emergence. While the PRST score remains a valuable clinical adjunct, particularly in resource-limited settings where BIS is unavailable, it should be interpreted with caution due to its susceptibility to confounding factors. The use of BIS monitoring should be considered for patients undergoing general anaesthesia, especially those at risk for awareness or haemodynamic instability, to optimize anaesthetic delivery and improve patient outcomes.

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