

ORIGINAL ARTICLE

Survival and Complication Rates of Implant-Supported Fixed Dental Prostheses in A Public Dental Postgraduate Training Centre in Malaysia: A Short-Term Cross-Sectional Study

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ABSTRACT

Introduction: Dental implants are a quintessential solution for replacing missing teeth, offering optimal function, aesthetics, and longevity. The objective of this study was to determine the success, survival, and complications associated with implant-supported fixed dental prostheses (FDPs) done in a public dental postgraduate training centre in Malaysia. **Methods:** Clinical records of patients aged 22 to 76 years involving at least one implant with FDP, functioning for at least one year, with the presence of an intraoral periapical radiograph, were included. Demographic data, implant information, pre-implant assessment, surgical details, prosthetic details, and maintenance status were recorded and analysed using Statistical Package for the Social Sciences (SPSS) software. **Results:** 109 implants (58 patients) were analysed over a mean follow-up period of 20.3 ± 9.4 months. Implant-supported FDPs showed 84.4% success rate and 99.1% survival rate with complications being 6.4% biological and 8.3% mechanical. Biological complications included peri-implant mucositis (3.7%), peri-implantitis (1.8%), sensitivity (0.9%), and explantation (0.9%). Mechanical complications included improper prosthetic contour (2.8%), ill-fitting prostheses (2.8%), prosthetic mobility (1.8%), and the presence of a gap between the implant and its surrounding tissues (0.9%). Though comorbidities, implant location, implant system, alveolar ridge preservation, and FDPs retainer type showed a possible correlation with implant therapy outcome ($p < 0.25$), the logistic regression only showed the presence of comorbidities ($p = 0.027$, $OR = 4.320$) and cement-retained FDPs ($p = 0.027$, $OR = 7.459$) significantly increasing the implant complication rate. **Conclusion:** Implant-supported FDPs demonstrates predictable short-term outcome, with survival rate up to 99.1%. Presence of systemic comorbidities and use of cement-retained FDPs are significantly associated with increased risk of implant-related complications.

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ability to minimise the biological impact on adjacent natural teeth while offering favourable functional, aesthetic, and durable outcomes (1-4). Implant-supported FDPs comprise crowns, fixed-fixed bridges, and cantilever bridges, which are affixed either by screwing or cementing onto dental implants or implant abutments (5).

INTRODUCTION

The evolution of dental practice has facilitated the emergence of diverse treatment modalities for the replacement of missing teeth. Among these options, implant-supported fixed dental prostheses (FDPs) have gained recognition as a superior choice due to their

The implant-supported FDPs are deemed successful when they remain unchanged, devoid of complications, and require no intervention throughout the observation period (6). Conversely, survival denotes the retention of FDPs in situ, with or without modifications, over the observation period (6-8). Meta-analyses revealed 5-year

success rates for implant-supported FDPs to be 61.3% and 66.4% respectively, in 2007 and 2012 (6, 7). These studies also indicated 5-year survival rates approaching 95%, albeit experiencing a notable decline over 10 years (6, 7). Moreover, several other meta-analyses had demonstrated promising 5-year survival rates exceeding 95% for implant-supported single crowns (SCs) (3, 8-10). While a study illustrated comparable survival rates of up to 97% between zirconia-based and metal-ceramic implant-supported SCs, some other studies reported significantly higher survival rates for metal-ceramic SCs compared to all-ceramic alternatives (3, 8).

The aforementioned meta-analyses underscore the reality that implant-supported FDPs, despite being regarded as optimal for tooth replacement, are susceptible to complications over time, encompassing both biological and mechanical issues. Reported complication rates for implant-supported FDPs stand at 38.7% and 33.6% (6, 7). A study conducted in Australia indicated cumulative incidences of biological and mechanical complications at 17.6% and 14.1% respectively, for implant-supported SCs (11).

Biological complications commonly associated with implant-supported FDPs include peri-implantitis and soft tissue complications, with an occurrence rate of up to 8.5% (6, 7). Additionally, marginal bone loss exceeding 2 mm around implant-supported SCs, considered a biological complication, had been reported at a prevalence of up to 6% (6, 7). Regarding mechanical complications, studies revealed veneering material fracture as the most prevalent issue for implant-supported FDPs, with an occurrence rate of up to 12% (6, 7). Conversely, some other studies highlighted abutment screw loosening as the predominant mechanical complication for implant-supported SCs (9). Other mechanical complications documented across various meta-analyses include loss of cement retention, abutment or screw fracture, loss of access hole restoration, implant fracture, and framework fracture (3, 6-9).

The success, survival, and complications associated with implant-supported FDPs are influenced by multiple factors, including patient-related variables, operator skill, surgical technique, and the restorative components (12). In addition to these, gingival phenotype plays an indirect yet significant role, as individuals with a thin gingival phenotype are at a higher risk of developing peri-implant disease (13, 14). Studies have shown that Asian populations tend to exhibit thinner gingival phenotypes compared to individuals of European ancestry (15). However, as most publications on implant therapy outcomes predominantly include participants of European descent, this has contributed to a lack of generalizable data for other ethnic and racial groups, including Southeast Asian and Malaysian populations. Therefore, the aims of this study are to: (1) describe the demographic profile of patients receiving implant-

supported FDPs; (2) determine the success and survival rates of implant-supported FDPs; and (3) report the incidence of complications associated with implant-supported FDPs at a public dental postgraduate training centre in Malaysia.

MATERIALS AND METHODS

Data retrieval

Patient folders with records of implant placement in Universiti Kebangsaan Malaysia (UKM) were obtained from the Department of Periodontics, Department of Restorative Dentistry, and Department of Oral & Maxillofacial Surgery. The folders were screened to acquire those who fulfilled the inclusion criteria: adults over the age of 18 years with at least one implant placed and restored in UKM in the time frame of January 2000 to December 2023, presence of intraoral radiographs at the time of loading with FDPs, implant-supported FDPs that had been in function for at least one year, with complete patient records from pre-implant surgery up to implant loading with FDPs. The exclusion criteria included subjects with implant-supported removable dental prostheses, absence of intraoral periapical radiographs at the time of loading with FDPs, implant-supported FDPs that had been in function for less than 12 months, and incomplete patient records associated with the implant-supported FDPs.

Relevant information was collected from the patient records, namely the demographic data, implant specifications, pre-implant assessment, implant surgery details, implant prosthetic information, and maintenance records. The demographic data at the patient level includes age, gender, education level, and occupation. Meanwhile, at the operator level, the department and role of the specialist or postgraduate trainee were recorded. Implant information, such as the number and location of the tooth replaced, and the implant system used, was obtained. As for the pre-implant assessment, information regarding the patient's comorbidities and periodontal diagnosis was retrieved. Information regarding pre-implant surgery, namely bone augmentation and sinus lift, was recorded, along with surgical stent usage and the need for second-stage surgery prior to restorative procedures. Furthermore, in relation to the implant prosthesis, the impression technique and material used were retrieved, along with the type of prosthesis and its loading time. Implant maintenance records, namely the duration after implant loading and the presence of any biological complications (peri-implant mucositis, peri-implantitis, sensitivity, implant explantation) or mechanical complications (prosthetic mobility, improper prosthetic contour, ill-fitting crown, implant and surrounding tissue gap) were collected into the database.

An analysis of patient information, as well as implant

success, survival, and failure rates, was conducted using the database. Implant success was defined as: 1) absence of signs and symptoms; 2) no record of mobility of implant; 3) no persistent peri-implant radiolucency; and 4) negligible bone loss after physiologic remodeling during the first year of function (16). Implant failure was defined as implants that were removed for any reason during the observation period. Implants that were still functioning in the patient's mouth despite having complications were defined as implant survival. Additionally, implants were diagnosed to be healthy or having a peri-implant disease based on the 2017 classification of periodontal diseases and conditions (17).

Data analysis

Statistical analysis was done using the Statistical Package for the Social Sciences (SPSS) Version 29 software. Descriptive analysis was performed for data at the patient level and implant level. Correlation between various variables and implant complications was determined using either Pearson's chi-square test, Point-biserial correlation coefficient test, or Fisher's exact test; $p < 0.25$ indicated possible correlation (18). The associated factors contributing to the implant complications were then further analysed using binomial logistic regression with a statistical significance of $p < 0.05$.

RESULTS

Demographic profile of patients

Among 71 patient folders reviewed, 58 patients were included in this study, with a total of 109 implants placed between the years 2006 and 2022, with a mean maintenance period of 20.3 ± 9.4 months (ranging from 13 to 71 months). The average age of the study population was 50.0 ± 13.3 years (ranging from 22 to 76), with 28 males and 30 females. The demographic profile of the patients is summarised in Table I. The attributes and qualities of the implants provided, along with surgical procedures utilised and restorative methods, are detailed in Table II.

Table I: Demographic profile of patients receiving implant treatment at a public dental postgraduate training centre in Malaysia

Total patients: 58 (100%)	
Age	50.0 ± 13.3 years old, ranging from 22 to 76
Gender	Male: 28 (48.3%) Female: 30 (51.7%)
Comorbidities	Yes: 17 (29.3%) No: 41 (70.7%)
History of periodontitis	Yes: 17 (29.3%) No: 41 (70.7%)
Number of implants	Average 1.9 ± 1.3 implants/subject, ranging from 1 to 7

Success and Survival Rates of Implant Treatment

At the patient level, 74.1% (43 patients) were categorised as successful, and one patient (1.7%) experienced

Table II: Characteristics and features of the implants, surgical procedures, and restorative techniques at a public dental postgraduate training centre in Malaysia

Total implants	109 (100%)
Location	Anterior: 23 (21.1%) Posterior: 86 (78.9%)
Department placed	Periodontics: 60 (55.0%) Restorative: 24 (22.0%) Prosthodontic: 11 (10.1%) Oral & Maxillofacial Surgery: 14 (12.8%)
Operator level	Specialist: 42 (38.5%) Postgraduate: 67 (61.5%)
Implant system	Straumann: 61 (56.0%) Astra: 19 (17.4%) Nobel: 15 (13.8%) Unspecified: 14 (12.8%)
Alveolar ridge preservation performed	Yes: 10 (9.2%) No: 99 (90.8%)
Ridge augmentation performed	Yes: 21 (19.3%) No: 88 (80.7%)
Sinus lift performed	Yes: 9 (8.3%) No: 100 (91.7%)
Staged approach	One-stage: 35 (32.1%) Two-stage: 74 (67.9%)
Stent usage	Yes: 45 (41.3%) No: 15 (13.8%) Unspecified: 49 (45.0%)
Adjunctive technique usage	Yes: 21 (19.3%) No: 88 (80.7%)
Impression technique	Open tray: 41 (37.6%) Closed tray: 19 (17.4%) Unspecified: 49 (45.0%)
Impression material	Silicone: 73 (67.0%) Polyether: 1 (0.9%) Unspecified: 35 (32.1%)
Type of prosthesis	Crown: 96 (88.1%) Bridge: 13 (11.9%)
Type of prosthetic material	Metal ceramic: 29 (26.6%) Zirconia: 22 (20.2%) Gold: 2 (1.8%) Unspecified: 56 (51.4%)
Type of retainer	Screw-retained: 64 (58.7%) Cement-retained: 34 (31.2%) Unspecified: 11 (10.1%)
Follow-up months(s)	Average 20.3 ± 9.4 months (ranging from 13 to 71 months)
Complications	Yes: 17 (15.6%) Biological: 8 (7.3%) Mechanical: 9 (8.3%) No: 92 (84.4%)

implant failure as a result of peri-implant bone loss. A total of fourteen patients (24.1%) were classified under survival due to the presence of implant complications. At the implant level, 99.1% (108 implants) of the implants survived, and only a single implant (0.9%) was explanted, indicating failure. Out of the 108 surviving implants, 92 implants (84.4%) met the success criteria, seven implants (6.4%) exhibited biological complications, and nine implants (8.3%) showed mechanical complications. The success and survival rates of implant treatment are summarised in Table III.

Table III: The success and survival rates of implant treatment in a public dental postgraduate training centre in Malaysia

	Implant Success	Implant Survival		Implant Failure
		Complication		
		Biological	Mechanical	
Patient level	74.1% (43/58)	10.3% (6/58)	13.8% (8/58)	1.7% (1/58)
Implant level	84.4% (92/109)	6.4% (7/109)	8.3% (9/109)	0.9% (1/109)

Factors Associated with Implant Complications

Among the numerous variables computed, only the presence of comorbidities within the patient ($p = 0.018$), location of the implant in the oral cavity ($p = 0.020$), the implant system used ($p = 0.223$), performing alveolar ridge preservation surgery prior to implant placement ($p = 0.154$), and type of retainer used for the implant prosthesis ($p = 0.103$) showed possible correlation with the occurrence of implant complications. Other factors did not show statistical possibilities of causing implant complications in this study ($p > 0.25$).

The logistic regression analysis revealed that the presence of comorbidities in patients receiving implant therapy significantly increases their possibility of experiencing implant complications ($p = 0.027$). The risk of developing implant complications is increased fourfold in patients having underlying medical illness compared to healthy patients; odds ratio (OR) = 4.320, 95% confidence interval (CI) = 1.179 – 15.821. Though other factors did not significantly increase the risk of developing implant complications, further analysis showed that cement-retained implant prostheses significantly increased the occurrence of implant complications compared to screw-retained implant prostheses ($p = 0.027$, OR = 7.459, 95% CI = 1.255 – 14.332).

Factors associated with implant complications have been summarised in Table IV.

Prevalence of Biological and Mechanical Complications
Among the biological complications, peri-implant mucositis (3.7%) recorded the highest incidence, involving four implants. This is followed by peri-

implantitis (1.8%) and sensitivity (0.9%). One implant (0.9%) was explanted due to bone loss, thus recorded as failure. The mechanical complications mainly comprised improper prosthetic contour and ill-fitting prosthesis, both involving three implants (2.8%) respectively. Prosthetic mobility (1.8%) and the presence of gap between the prosthesis and surrounding tissue (0.9%) were also recorded. The summary of biological and mechanical complications is illustrated in Table V.

Table V: Incidence of biological and mechanical complications of implants placed in a public dental postgraduate training centre in Malaysia

Biological Complications	Incidence (%)
Peri-implant mucositis	3.7 (4/109)
Peri-implantitis	1.8 (2/109)
Sensitivity	0.9 (1/109)
Implant explantation	0.9 (1/109)
Mechanical Complications	Incidence (%)
Improper prosthetic contour	2.8 (3/109)
Ill-fitting prostheses	2.8 (3/109)
Prosthetic mobility	1.8 (2/109)
Gap between prosthesis and surrounding tissue	0.9 (1/109)

DISCUSSION

Implant therapy is indeed a promising treatment option, as this study has shown a survival rate of 98.2% at the patient level and 99.1% at the implant level, with only one implant failure observed over a mean follow-up period of 20.3 ± 9.4 months. These encouraging results are consistent with previous short-term studies, which have similarly reported implant survival rates exceeding 98% (19-21). Although the present findings are based on a relatively short-term follow-up, a systematic review by Kadkhodazadeh et al. (2024) found no significant difference in implant success and survival rates when comparing short-term and long-term outcomes, further supporting the reliability of implant therapy across time spans (22).

Although dental implants generally demonstrate high success and survival rates, complications and failures may still occur. In the present study, the most prevalent biological complications were peri-implant mucositis and peri-implantitis, affecting 3.7% and 1.8% of implants, respectively. Similarly, Atieh et al. (2013) reported peri-implant mucositis and peri-implantitis as major biological concerns in their systematic review and meta-analysis of implants functioning for at least five years, with prevalence rates of 30.7% and 9.6%, respectively (23). The notably lower incidence observed in the current study may be attributed to the shorter mean follow-up period, as peri-implant diseases, particularly peri-implantitis, are strongly associated with longer functional time (24, 25). Furthermore, variability in diagnostic criteria, including bleeding-on-probing thresholds, probing depths, and examiner calibration, can significantly influence reported prevalence rates

Table IV: Factors influencing the occurrence of implant complications at a public dental postgraduate training centre in Malaysia

	Crude value			Adjusted value		
	p-value	Odds Ratio (OR)	95% Confidence Interval (CI) Lower Upper	p-value	Odds Ratio (OR)	95% Confidence Interval (CI) Lower Upper
Systemic Factors						
Age	0.473 [^]					
Gender	0.649*	1.314	0.405 4.269			
Comorbidities	0.018*	4.317	1.234 15.107	0.027 €	4.320	1.179 15.821
History of periodontitis	0.691*	1.292	0.365 4.57			
Implant Factors						
Implant location	0.020*	0.750	0.667 0.844			
Number of implants	0.680 [^]					
Implant system	0.223 [†]					
Maintenance month(s)	0.396 [^]					
Department placed	0.412 [†]					
Operator level	0.400*	0.619	0.201 1.905			
Surgical Factors						
Alveolar ridge preservation	0.154*	0.891	0.830 0.957			
Bone augmentation	0.628*	1.357	0.394 4.682			
Sinus lift	0.567*	1.619	0.306 8.554			
Staged approach	0.383*	0.625	0.216 1.810			
Adjunctive technique	0.628*	1.357	0.394 4.682			
Surgical stent usage	0.511 [†]					
Restorative Factors						
Prosthetic type	0.982*	0.982	0.197 4.883			
Prosthetic material	0.877 [†]					
Retainer type	0.103 [†]			0.130 €	1.917	0.826 4.445
Impression technique	1.000 [†]					
Impression material	0.300 [†]					

Significance: p < 0.05
[^] - Point-biserial correlation coefficient test
^{*} - Pearson's chi-square test
[†] - Fisher's exact test
[€] - Binomial logistic regression

(17, 26).

The most frequently observed mechanical complication in this study was improper prosthetic contour (2.8%), attributed to the clinical presence of bulbous or over-contoured restorations. Although prosthetic contour was not objectively assessed, such as by measuring the emergence angle of the prostheses relative to the long axis of the implant fixture or abutment, previous studies have reported that an emergence angle greater than 30° is a significant risk factor for peri-implantitis (27, 28). In contrast to the present findings, the existing literature has consistently identified abutment screw loosening and chipping of veneering material as the most common mechanical complications associated with implant-supported fixed dental prostheses (3, 6, 7, 9, 29).

In the present study, patients with comorbidities demonstrated a significantly increased risk of implant complications. Compared to medically healthy individuals, those with cardiac conditions, diabetes mellitus, hypertension, and Human Immunodeficiency Virus (HIV)-positive status were associated with higher complication rates ($p = 0.027$; $OR = 4.302$). These findings are supported by Samara et al. (2024), who reported that systemic conditions such as cardiovascular disease and uncontrolled diabetes, along with medications like bisphosphonates and immunosuppressants, can negatively affect osseointegration, thereby increasing the risk of implant failure (30). Interestingly, a 2016 study observed higher implant survival rates among patients on antihypertensive therapy, attributing the positive outcome to the drugs' favourable effects on bone metabolism and osseointegration (31). Additionally, a systematic review concluded that dental implants are safe for HIV-positive patients with normal CD4+ counts and well-controlled systemic risk factors, as their implant survival rates and marginal bone loss were comparable to those of HIV-negative individuals (32).

The single implant failure observed in this study occurred in a patient with poorly controlled diabetes mellitus. This finding aligns with existing evidence indicating that individuals with inadequate glycaemic control are at increased risk of developing peri-implantitis, which may ultimately result in implant failure and explantation (33). Poor glycaemic control negatively affects osseointegration by reducing osteoblastic activity, enhancing osteoclastic activity, and promoting the accumulation of advanced glycation end products, all of which compromise bone healing around implants (34).

Our study also revealed that cement-retained implant prostheses were associated with a higher risk of complications compared to screw-retained prostheses. This observation is supported by existing literature, which indicates that excess subgingival cement is associated with clinical signs of peri-implant disease

(35). Residual cement may contribute to peri-implant pathology by triggering a foreign body reaction, eliciting allergic responses, altering the implant surface, or serving as a nidus for microbial adhesion and proliferation (36). However, meta-analyses examining the retention type of implant prostheses have reported conflicting results. Lemos et al. (2016) observed higher implant survival rates and reduced marginal bone loss in cement-retained prostheses compared to screw-retained counterparts (37), whereas Reis et al. (2023) found no significant difference in the incidence of peri-implant disease between the two retention types (38).

In the present study, no significant correlation was found between a history of periodontitis and the occurrence of implant complications. This finding may be attributed to the limited sample size available for analysis. Previous studies have reported that individuals with a history of periodontal disease are more susceptible to peri-implantitis (26). One possible explanation is the persistent presence of periodontitis-associated microorganisms in periodontally compromised patients, which may colonize the surfaces of newly placed implants. This microbial invasion can initiate inflammatory responses, leading to peri-implant tissue breakdown and marginal bone loss (39).

According to the Implant Disease Risk Assessment (IDRA) tool introduced in 2020, regular implant maintenance is essential for ensuring long-term treatment success (40). Patients who receive implant therapy should be enrolled in a structured recall program for supportive periodontal care, as this has been shown to reduce the risk of both biological and mechanical complications. A recall interval of five months or less has been identified as effective for maintaining peri-implant health (41). However, in the present study, no significant association was found between maintenance recall compliance and implant complications, likely due to the limited number of patient records available for analysis.

In our study, although implant location appeared to show a potential correlation with complications, further statistical analysis could not be performed due to the unequal distribution of implants between anterior and posterior regions, which violated the assumption of normality. Nonetheless, previous studies have reported a significant association between implant success and location, which may be attributed to variations in bone quality across different regions of the jaw (42).

Similarly, no further analysis between alveolar ridge preservation and implant complications was conducted, despite an apparent association between these variables. This limitation was primarily due to incomplete documentation in some of the case records. The success of implant therapy following alveolar ridge preservation is known to depend heavily on several factors, including the type of bone graft and membrane used, as well as

the surgical technique employed (43, 44).

Smoking is a well-established risk factor that negatively influences implant outcomes. Numerous studies have demonstrated that smokers are at significantly higher risk for implant failure and peri-implant disease due to impaired healing, reduced vascularity, and altered immune response (45, 46). Smoking has also been associated with increased marginal bone loss and decreased long-term implant survival. Unfortunately, in the present study, smoking status was not consistently documented in patient records, limiting the ability to assess its impact on clinical outcomes. Future studies should ensure systematic recording of smoking history to allow for more robust analysis of its role in implant success and complications.

This study had several limitations. First, the small sample size restricted the ability to accurately determine implant survival and complication rates. Second, incomplete treatment records led to more than 30% missing data, limiting the analysis of factors associated with implant therapy outcomes. Third, the lack of adequate radiographic documentation in patient files impeded comprehensive radiographic evaluation. Fourth, the relatively short follow-up period constrained the assessment of long-term implant success and delayed complications.

This study also identified several important directions for future research. Firstly, the inclusion of direct patient involvement through interviews, surveys, or patient-reported outcome measures, combined with retrospective analysis of clinical records, can provide valuable insight into patient satisfaction, perceived treatment outcomes, and quality of life following implant therapy. This dual approach allows for a more holistic understanding of the impact of dental implants beyond clinical parameters alone. Secondly, the integration of standardized and comprehensive radiographic assessments, including baseline and follow-up imaging, is crucial for accurately evaluating peri-implant bone levels, identifying early signs of complications, and enhancing the overall reliability of outcome measures. These improvements in data collection and patient engagement will contribute to a more robust evidence base for optimizing implant therapy protocols in the future.

We also recommend the implementation of standardized record-keeping protocols for patients undergoing implant therapy in dental postgraduate training centres. As educational institutions, these centres have a dual responsibility to ensure high-quality patient care and to support ongoing research. Systematic documentation would not only enhance continuity of care but also ensure that essential clinical information is readily accessible for future research and audit purposes.

CONCLUSION

This study demonstrates that implant-supported fixed dental prostheses (FDPs) exhibit high short-term success and survival rates, supporting their role as a safe and predictable treatment option, despite the occurrence of biological and mechanical complications. Patient-related factors, particularly the presence of comorbidities such as cardiac conditions, diabetes mellitus, hypertension, and HIV-positive status, were found to significantly influence implant outcomes. Additionally, screw-retained FDPs were associated with a lower risk of complications compared to cement-retained counterparts. While a history of periodontitis and adherence to maintenance recall protocols were not identified as significant prognostic factors in this study, they remain clinically relevant considerations for optimizing long-term implant success.

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COMPETING INTERESTS

The authors declare that they have no competing interests.

ETHICAL CLEARANCE

We obtained approval from the Research Ethics Committee UKM (RECUKM), registered under JEP-2023-327.

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