Evaluation of Results of Unstable Intertrochanteric Femoral Fracture Fixation by Proximal Femoral Nail "PFN " Versus Dynamic Hip Screw

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Abstract
Background: The most common implant used for intertrochanteric fractures is the dynamic hip screw (DHS). For the treatment of unstable fractures, cephalo-medullary devices are recommended, especially in cases where medial buttressing is absent. The proximal femoral nail (PFN) was devised by the AO/ASIF and included an additional anti-rotation hip pin, a lower load-bearing neck screw, and two proximal screws.
Objectives: To assess outcomes of unstable Intertrochanteric Femoral Fracture fixation using Proximal Femoral Nails (PFN) versus DHS.
Patients and methods: This prospective study was carried out on 40 patients with clinical criteria of unstable intertrochanteric femur fracture. Patients were divided into two equal groups: PFN group and DHS group.
Results: Incision length and fluoroscopy time were significantly higher in DHS group than PFN group (P value=0.001 and 0.002). VAS showed non-significant differences. Aid usage, union time, full weightbearing time, infection, non-union, lag screw cut through, metal failure and for revision were insignificantly different between both groups. Malunion didn't occur in any patient in both groups.
Conclusion: Our study found no significant difference between PFN and DHS with regards to pain scores, Harris hip scores, gait patterns, ambulation distances, assistive device utilization, time to union, time to full weight-bearing, and postoperative complication rates. However, the DHS technique was associated with a larger incision length and increased fluoroscopy time compared to the PFN technique.
Keywords: Intertrochanteric femoral fracture; Dynamic hip screw; Calcar femoral; Proximal femoral nail.
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Introduction

Due to longer lifespans and a higher frequency of traffic accidents, the prevalence of intertrochanteric fractures has increased. Nearly half of hip fractures in the elderly population are intertrochanteric fractures. In order to lower the risk of medical complications and restore the patient to their pre-operative state, the goal of treating any intertrochanteric (IT) fracture is to allow for early mobility **(Lakhmania, 2020).**

In the younger demographic, it is rarely observed, and when it does occur, it is attributable to high-velocity trauma. These fractures constitute roughly 50% of hip fractures in the elderly, of which 35-40% are classified as unstable according to the AO Foundation and the Orthopedic Trauma Association (OTA) (AO/OTA) classification. Notwithstanding the advancement of numerous implants throughout history, the morbidity associated with this fracture continues to be elevated. Non-operative therapy is associated with a significant incidence of malunion and comorbidities **(Raj, 2020).**

While the most commonly used implant for intertrochanteric fractures is the dynamic hip screw (DHS), the intact calcar femoral bears the majority of the stress in the proximal femur. As a result, the laterally positioned plate's lever arm is increased, increasing the possibility of implant cut-out in the event that the calcar is compromised **(Shukla et al., 2022).**

When compared to a laterally fixed side plate, an intramedullary device biomechanically lessens the bending load that the hip joint places on the implant by 25–30%. For elderly patients, whose immediate complete weight-bearing mobilization is the main therapeutic goal, this is very advantageous. When treating unstable fractures, especially when medial buttressing is not available, cephalomedullary devices are the recommended method **(Hongal, 2020).**

The Gamma nail is the prototype cephalomedullary nail; nonetheless, significant implant-related problems, including femoral shaft fractures and fixation failures necessitating reoperation, have been documented. The predominant technical failures involve the collapse of the fracture site and the extraction of the neck screw, attributed to the rotational potential of the head–neck fragment **(Lewis et al., 2022).**

To solve these problems, the AO/ASIF developed the proximal femoral nail (PFN) in 1997. It has two proximal screws, a lower load-bearing neck screw, and an extra antirotation hip pin. According to published research, the PFN is a reliable implant that produces outcomes similar to those for unstable proximal femoral fractures (PFFs) **(Yee, 2024).**

This study aimed to evaluate and contrast the results of fixating unstable intertrochanteric femur fractures with proximal femoral nails (PFN) and dynamic hip screws.

Patients and methods

This prospective quantitative experimental comparative study was carried out on 40 patients. The study was done from 2020 to 2024 after approval from the Ethical Committee Qena University Hospitals. An informed written consent was obtained from the patient. Patients were divided into two equal groups: PFN group and DHS group.

Inclusion criteria: patients aged 30-90 years old, patents presented with unstable intertrochanteric femur fracture defined as A2 or A3 fracture according to the AO/OTA Classification.

Exclusion criteria: patients aged below 30 and above 90 years old, stable intertrochanteric femur fracture defined as A1 fracture according to the AO/OTA Classification, patients with previous surgery in the proximal femur, coagulopathy, uncontrolled chronic diseases like hypertension, diabetes mellitus, renal or liver function tests.

Sample size justification: The sample size was calculated based on the findings by **Parikh et al., 2018,** where the DHS yielded satisfactory Harris hip score in 24 cases (92%) compared to 25 cases (96%) who had PFN (P = 0.552). The calculated sample size was 17 for each group. To avoid the risk of drop out during the follow up, the sample size was increased to 20 for each group.

All patients were subjected to complete history taking, general examination, vital signs [Blood pressure, temperature, heart rate, and respiratory rate], body mass index, local examination of the affected limb, routine laboratory investigations and plain X-ray.

Plain radiographs including anteroposterior and lateral radiographs of both hips were performed for diagnosis and for the assessment of the fracture pattern, and stability. Fractures were classified according to AO classification system for intertrochanteric fracture: A1: Peri trochanteric simple two parts and intact lateral cortex. A2: per trochanteric with separate posteromedial fragment, intact lateral cortex and fracture of lesser trochanter. A3: fracture extends through lateral, medial cortex and reverse oblique fracture **(Alsayed et al., 2021).**

Preoperatively

Each patient received two units of blood, with usage determined by the patient's specific needs. All patients received a prophylactic antibiotic, Ceftriaxone, at a dosage of 1g per 24 hours, and one liter of Ringer's solution was administered on the morning of the procedure as part of preoperative hydration. All procedures were performed under spinal anesthesia. Low molecular weight heparin (40 I.U. once day) was administered for deep vein thrombosis prophylaxis and started 12 hours before the procedure.

In Proximal femoral nail group Güran and Gencer (2024): The patient was positioned supine on a radiolucent table, with the uninjured leg in a hemi-lithotomy position and the upper body tilted 10–15º contralaterally. Closed reduction was performed under fluoroscopic guidance and maintained with traction. A 3–5 cm incision was made from the greater trochanter's tip, extending proximally. The gluteus medius was split along its fibers, and a cannulated awl was inserted at the trochanteric apex. A 3.2 mm guidewire was advanced centrally through the proximal femur, followed by reaming (8–13 mm) of the medullary canal, except in cases of proximal femur comminution or fractures extending to the greater trochanter, where proximal reaming was omitted. A long proximal femoral nail (PFN) was then manually inserted over the guidewire with a twisting motion and its position confirmed fluoroscopically. For proximal fixation, a 130º aiming arm guided the placement of a lag screw centrally in the femoral head, along with an anti-rotation hip pin superior to it. For distal locking, a 4 mm cortical screw was inserted through a targeting device using a 3.2 mm drill bit, confirmed under fluoroscopy. Final imaging verified fracture reduction and implant positioning before guide wire removal. The surgical site was irrigated, the Ilio-tibial band approximated without a drain, and the skin closed with standard wound dressing.

In Dynamic Hip screw (DHS) group López et al. (2023): The patient was positioned on a radiolucent table with both legs on rails and received general anesthesia. Traction in abduction and internal rotation was applied to reduce the fracture, with open reduction via a lateral approach performed if closed reduction was unsuccessful. After reduction, the patient was draped, and a Dynamic Hip Screw (DHS) angled guide (135º or 140º) was attached. A threaded DHS guide wire was inserted centrally into the femoral head and neck, reaching the subchondral bone, and remained in place throughout the procedure. The DHS reamer was removed, and the DHS tap with a centering sleeve was used to ensure accurate placement. The lag screw (typically 75–95 mm) was inserted into the femoral head over a long centering sleeve, ensuring it reached the lateral cortex when the zero mark on the window was aligned, with the wrench handle parallel to the femoral shaft. The DHS plate (four-hole or six-hole, depending on fracture stability and bone quality) was then slid up the femoral shaft and secured after removing the guide wire. The DHS compression screw was applied to achieve fragment compression before the plate was fixed to the femoral shaft with cortical screws. A suction drain was placed under the muscle, and fluoroscopy confirmed fracture fixation. The wound was irrigated and closed in layers, and procedural details such as incision length, fluoroscopy duration, operation time, and blood loss were recorded.

Post-operatively, Ceftriaxone 1g per 24 hours was administered as part of a preventative antibiotic regimen to all patients for five days following surgery. For two to three weeks following surgery, low molecular weight heparin (40 I.U. once daily) was given. To confirm appropriate reduction and implant placement, immediate postoperative X-rays were taken. On the second postoperative day, all patients began hip and knee range-of-motion (ROM) exercises and quadriceps strengthening. Partial weight-bearing (PWB) typically began at 2–6 weeks postoperatively. By 6–8 weeks, patients gradually progressed to full weight-bearing (FWB) as tolerated, depending on radiographic evidence of healing. Active hip abduction and flexion exercises were introduced, followed by closed-chain strengthening and balance training at 8–12 weeks. Regular follow-ups with clinical and radiographic evaluations guided rehabilitation progression.

Follow up

Follow-up visits were scheduled at 6 weeks, 12 weeks and 6 months postoperatively for all patients. After the sutures were removed after two weeks, the patients were observed for follow-up X-rays conducted at follow-up visits. Radiographs taken laterally and anteriorly were evaluated for union. While delayed union refers to the inability to show radiological evidence of complete fracture union within six months, union is defined as painless full weight-bearing on the affected limb together with radiographic consolidation.

Radiographs were used to assess lag screw location, and non-union was defined as the lack of radiological evidence of full union by nine months. The Visual Analog Scale (VAS), according to **Wildemann et al. (2021),** is a unidimensional instrument that involves a line that runs from zero to 10, with endpoints designated "no pain" and "worst imaginable pain."

Pain was classified as either mild (1–3), moderate (4–6), severe (7–10), or nonexistent (0). The Harris hip score was used by **Comelon et al. (2021)** to assess functional outcomes. The evaluation included a thorough analysis of the hip joint's range of motion, the patient's functional condition, and complaints including discomfort and limping. Results fall into one of four categories: bad (less than 70), fair (70–79), good (80–89), or outstanding (90–100). **Ramadanov et al. (2024).** At six months, the Harris hip score was evaluated, and any issues resulting from the operation were noted and documented.

Outcomes: Primary outcomes were the postoperative Harris hip score and the Visual Analog Scale. Secondary outcomes included the need for aid, union time, full weight bearing time and complications rate.

Ethical approval code: SVU-MED-ORT017-1-24-3-834.

Statistical analysis

SPSS version 26 was used for the statistical analysis (IBM Inc., Chicago, IL, USA). Normality of data distribution was assessed using histograms and the Shapiro-Wilk test. The Mann-Whitney test was used to compare abnormally distributed continuous data. T-test was used to compare normally distributed continuous data. The Chi-square test was used to compare non-continues data and Fisher's exact test was used to compare non-continuous data if one of the comparisons cells had 0 cases. Statistical significance was defined as a two-tailed P value of less than 0.05.

Results

Age was significantly higher in DHS group than PFN group (P value =0.014). The type of fracture and mode of trauma were insignificantly different between both groups. (**Table.1**).

Table 1. Demographic data and mode of trauma of the studied groups

Variables		PFN group (n=20)	DHS group (n=20)	P value
Age (years)		67.45±6.43	73.45±8.19	**0.014*** [t]
Type of fracture	**A1**	0 (0%)	0 (0%)	0.490 [X]
	A2	13 (65%)	15 (75%)	
	A3	7 (35%)	5 (25%)	
Mode of trauma	**Fallen of the ground**	16 (80%)	14 (70%)	0.716 [X]
	Fallen from height	4 (20%)	6 (30%)	

Data is presented as mean ± SD, median or frequency (%). * Statistically significant (p value <0.05). t: student t-test, X: chi square test.

Incision length and fluoroscopy time were significantly higher in DHS group than PFN group (P value =0.001 and 0.002 respectively). Operative time, Harris hip score after 3 months (figure 2), limpness and walking distance was insignificantly different between both groups. VAS (figure 1) score was insignificantly different in 2 weeks, 6 weeks, 12 weeks and 6 months between both groups. (**Table.2, Figs 1,2**).

Table 2. Incision length, fluoroscopy, operative time, VAS score, Harris hip score after 3 months, limpness and walking distance of the studied groups

Variables		PFN group (n=20)	DHS group (n=20)	P value
Incision length (cm)		7.45 ± 1.47	10.9 ± 2.22	**0.001*** [MWU]
Fluoroscopy time(h)		1.1 ± 0.31	1.55 ± 0.51	**0.002*** [MWU]
Operative time (h)		2.15 ± 0.37	2.35 ± 0.49	0.152 [MWU]
VAS score	**2 weeks**	6.14 ± 1.14	6.44 ± 1.21	0.425 [MWU]
	6 weeks	4.05 ± 0.93	4.44 ± 1.46	0.320 [MWU]
	12 weeks	2.41 ± 0.94	2.33 ± 1.45	0.837 [MWU]
	6 months	0.73 ± 0.91	1.06 ± 1.68	0.445 [MWU]
Harris hip score after 3 months		23.2 ± 3.61	19.65 ± 8.13	0.082 [MWU]
Limpness	**Little**	18 (90%)	15 (75%)	0.178 [f]
	Moderate	2 (10%)	3 (15%)	
	Severe	0 (0%)	3 (15%)	
Walking distance	**6 blocks**	11 (55%)	12 (60%)	0.420 [f]
	Indoor activities	1 (5%)	1 (5%)	
	Restricted to bed or need chair	0 (0%)	2 (10%)	
	No limitations	8 (40%)	5 (25%)	

VAS: Visual analog scale. * Statistically significant (p value <0.05). MWU: Mann Whittney U test, f: Fisher exact test.

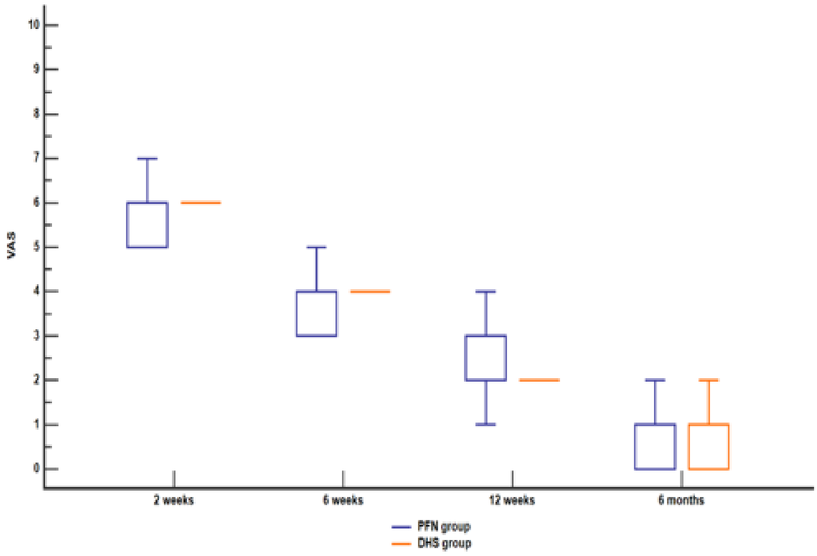

Fig.1. VAS of the studied groups.

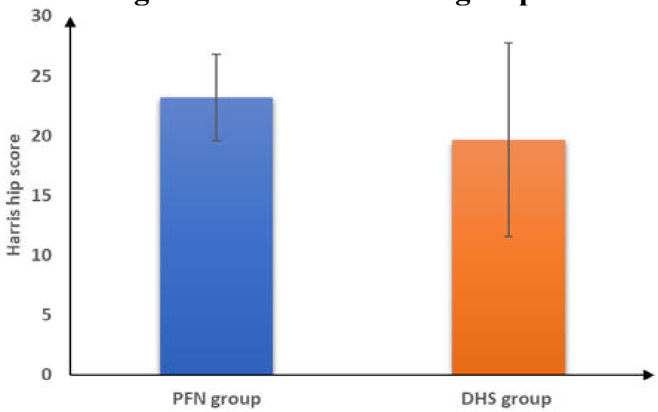

Fig.2. Harris hip score after 3 months of the studied groups.

Aid usage, union time, full weightbearing time, infection, non-union, lag screw cut through, metal failure and for revision were insignificantly different between both groups. Malunion didn't occur in any patient in both groups. (**Table.3**)

Table 3. Aid usage, union time, full weightbearing time and complications of the studied groups

Variables		PFN group (n=20)	DHS group (n=20)	P value
Aid usage	**Single cane**	2 (10%)	0 (0%)	0.131 [f]
	Not required	18 (90%)	15 (75%)	
	Completely unable to walk	0 (0%)	2 (10%)	
	Single crutch	0 (0%)	2 (10%)	
	Two crutches	0 (0%)	1 (5%)	
Union time	**3 Months**	19 (95%)	17 (85%)	0.485 [f]
	6 Months	0 (0%)	1 (5%)	
	No	1 (5%)	2 (10%)	
Full weightbearing time	**2 Months**	15 (75%)	14 (70%)	0.170 [f]
	3 Months	5 (25%)	3 (15%)	
	No	0 (0%)	3 (15%)	

Complications	**Infection**	0 (0%)	2 (10%)	0.217 [f]
	Malunion	0 (0%)	0 (0%)	---
	Non-union	1 (5%)	1 (5%)	0.990 [X]
	Lag screw cut through	1 (5%)	3 (15%)	0.605 [X]
	Metal failure	2 (10%)	0 (0%)	0.990 [f]
	For revision	3 (15%)	3 (15%)	0.990 [X]

Data is presented as frequency (%).f: Fisher exact test, X: chi square test.

Discussion

Unstable intertrochanteric fractures of the femur are challenging to treat, and the surgical management of these injuries remains a topic of debate, as the outcomes can be variable and complications such as loss of fixation and nonunion are not uncommon **(Martinho and Stoffel, 2021).**

One of the greatest alternatives for treatment of trochanteric fractures is the Dynamic Hip Screw (DHS) **Fu et al. (020).** The DHS has shown over several years that trochanteric fractures can be effectively stabilized with great functional results. A plate and screws are used to attach the DHS to the lateral side of the femur **Wang et al. (2020).** It has various benefits, including improving fracture healing because it permits controlled telescoping and impaction of the fracture while a patient is bearing weight. Yet there have also been reports linking the use of DHS in unstable intertrochanteric fractures to higher rate of screw cut out substantial shaft medial displacement due to excessive screw sliding inside the barrel **Babu et al. (017).**

For unstable intertrochanteric fractures, the intramedullary device, which consists of the proximal femoral nail (PFN) with various variations, is frequently utilized **Andalib et al. (2020).** Since then, nearly all types of trochanteric fractures have been treated with it. It is made up of an intramedullary nail with a proximal angulation of 6° that comes in both short and long forms and can be distally locked with either static or dynamic screws **Neradi et al. (2022).** It can withstand the compressive and tensile stresses induced by weight-bearing following the fracture procedure, thereby aligning the fulcrum of fracture restoration with the anatomical fulcrum **(Wang et al., 2020).**

The Proximal Femoral Nail (PFN) is an intramedullary, load-sharing device that provides superior stability for unstable intertrochanteric fractures by transmitting forces along the femoral shaft, reducing varus collapse, and offering rotational stability via an anti-rotation hip pin. Its shorter lever arm minimizes implant failure, and less soft tissue dissection preserves blood supply for faster healing **(Kumar et al., 2024).**

In contrast, the Dynamic Hip Screw (DHS) is an extramedullary, load-bearing device that relies on controlled impaction and sliding of the lag screw within the plate to promote fracture compression and healing. However, in unstable fractures, its longer lever arm increases the risk of varus collapse, excessive fracture shortening, and implant failure, particularly in osteoporotic bone. PFN is preferred for reverse obliquity, comminuted, and subtrochanteric fractures, while DHS remains effective for stable patterns **(Hanoun et al., 2021).**

The findings of this study showed that incision length and fluoroscopy time were significantly higher in DHS group than PFN group. Operative time was insignificantly different between both groups.

In agreement with our study, **Nofal et al. (2024),** illustrated that the incision length was significantly higher in DHS group than PFN group. On the other hand, fluoroscopy time was significantly lower in DHS group than PFN group and the duration of surgery was significantly longer in DHS group than PFN group. This difference in results might be attributed to the different study areas.

Coming in line with our findings, **Gill et al. (2017),** showed that the incision length was significantly higher in DHS group than PFN group. Also, **Zehir et al. (2015),** reported that the fluoroscopy time was significantly higher in DHS group than PFN group.

In the current study, VAS score was insignificantly different between both groups. Harris hip score after 3 months was insignificantly different between both groups.

This agreed with **Nofal et al. (2024),** who demonstrated that the Harris hip score was insignificantly different between DHS group and PFN group (81.4 ± 9.93 vs 86.41 ± 8.78; P = 0.140). But the pain score was significantly higher in the DHS group than PFN group with 5 patients from the DHS group reporting pain compared to 1 case from the PFN group (P = 0.01).

On the other hand, **Dubey et al. (2021),** illustrated that the mean Harris hip score for patients managed with PFN was significantly higher than in DHS group at 12 months after surgery (P = 0.05). This difference in findings might be due to differences in follow-up duration at which the score was measured. Such differences may be attributed to differences the sample size e included 386 cases with unstable intertrochanteric fractures of femur in follow-up duration, further causes may include as longer assessments capture better recovery. Fracture type, patient demographics, surgical expertise, and rehabilitation protocols also may impact outcomes.

According to our results, limpness was insignificantly different between both groups. The walking distance was insignificantly different between both groups. Aid usage was insignificantly different between both groups. Union time and full weightbearing time were insignificantly different between both groups.

In the same line, **Nofal et al. (2024),** highlighted that the union time was insignificantly different between the DHS group and PFN group as the mean time to union was 11.87 ± 2.2 weeks in the DHS group compared to 11.82 ± 2.94 weeks in the PFN group (P = 0.961).

However in contrast to our study, **Kamboj et al. (2019),** illustrated that the duration of full weight bearing was insignificantly different between the DHS group and PFN group. They found that the time of full weight bearing in the DHS group was 87.89±16.36 days compared to 49.20±10.18 days in the PFN group (P = 0.001). Such significant difference in time of weight bearing may be due to the post-operative protocol of rehabilitation which may differ from our protocol. Also, the difference in sample size may cause differences in the mean time required till full weight bearing.

The findings of the current study demonstrated that infection, non-union, lag screw cut through, metal failure and for revision were insignificantly different between both groups. Malunion didn't occur in any patient in both groups.

In agreement with our findings, **Nofal et al. (2024),** revealed that the screw cut out/ back outa and wound infection were insignificantly different between DHS group and PFN group as the complications were are among both groups (P = 0.493).

This agreed with a study performed by **Rathva et al. (2018),** on 60 patients with low-energy extracapsular per trochanteric stable femoral fractures divided equally into two groups: DHS group and PFN group. They observed that the implant failure, non-union and infection were insignificantly different between both groups.

Supporting our study **Rathva et al. (2018)**. PFN is considered as a rereliable fixation device which offers the advantage of a closed procedure with a more stable biomechanical construct for all trochanteric and sub-trochanteric fractures

So, our recommendations are the use of PFN technique is recommended in the management of unstable intertrochanteric femur fractures, further studies in other centers to compare findings, further studies with large sample size to produce significant results, further studies with longer follow up period, further a prospective, randomized controlled studies to avoid potential biases

Limitations: The primary limitations of our study include the relatively small sample size, which may limit the generalizability of the findings. The focus on the elderly age group, among which intertrochanteric fractures are common, may prohibit the generalizability of our findings among other different age groups. Alos, the relatively short follow up time of only 6 months which may miss the long-term outcomes. Thus, future studies with larger cohorts, longer follow-up periods are needed to validate and expand upon these findings.

Conclusion

Both Proximal Femoral Nail (PFN) and Dynamic Hip Screw (DHS) techniques demonstrate comparable efficacy in managing unstable intertrochanteric femur fractures, with no statistically significant differences observed in pain scores, Harris Hip Scores, gait patterns, ambulation distances, assistive device utilization, time to union, time to full weight-bearing, or postoperative complication rates. However, the DHS technique was associated with a larger incision length and prolonged fluoroscopy time compared to PFN. Given its superior biomechanical stability, particularly in cases of comminuted medial and lateral cortex involvement or reverse obliquity fractures, PFN is generally recommended as a more stable and reliable fixation method.

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