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Proximal femoral nail antirotation versus hemiarthroplasty in the treatment of senile intertrochanteric fractures: Case report

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ABSTRACT

BACKGROUND: Primary hemiarthroplasty was recommended by some surgeons as the preferred choice in treating unstable senile intertrochanteric fractures with osteoporosis. However, many studies reported that proximal femoral nail antirotation (PFNA) currently was as an optimal implant for the treatment of different type of intertrochanteric fractures. Which method is better for treating senile intertrochanteric fractures remains controversial due to the insufficient clinical evidences.

METHODS: We reviewed all consecutive senile intertrochanteric fractures treated with PFNA or cemented hemiarthroplasty at our institution between July 2010 and March 2015. The primary outcome measures were postoperative complications, reoperation rate and hip function. The secondary outcome measures were intraoperative blood loss, transfusion rate, surgical time, postoperative hemoglobin, hospital stay and 1- year mortality.

RESULTS: Seventy-one patients in PFNA group and 52 patients in hemiarthroplasty group were included for analysis. There were no significant differences between the two groups regarding to the orthopaedic complications, reoperation rate, surgical time and Harris Hip Score at 1 year follow-up. Significant differences were found between PFNA and hemiarthroplasty group in comparison of intraoperative blood loss ($P < 0.001$), transfusion rate, medical complications ($P = 0.037$) and hospital stay ($P = 0.001$). Patients treated with hemiarthroplasty had a trend of higher postoperative 1- year mortality compared to those underwent PFNA but this was statistically not significant ($P = 0.134$).

CONCLUSIONS: These findings indicate that PFNA has obvious advantages over hemiarthroplasty in the treatment of senile intertrochanteric fractures. Hemiarthroplasty in treating these fractures is associated with greater surgical trauma and higher incidence of postoperative medical complications.

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1. Introduction

Intertrochanteric fracture is a common injury in the elderly. The primary treatment for intertrochanteric fracture is internal fixation. However, senile intertrochanteric fractures treated with internal fixations are often associated with complications due to poor bone quality, such as metal failure, nonunion and femoral head perforation. Hip arthroplasty is always used as a salvage procedure for internal fixation failure [1,2]. Some studies reported that hip arthroplasty could shorten the weight bearing time, reduce the incidence of implant-related complications and improve the hip function when compared with internal fixations by Gamma nails, dynamic hip screws, and proximal femoral nails (PFN) [3,4]. In

order to prevent the reoperation due to internal fixation failure, some surgeons recommended hemiarthroplasty as the preferred choice for treating the unstable senile intertrochanteric fractures with osteoporosis [5,6]. Nevertheless recent studies indicated that proximal femoral nail antirotation (PFNA) currently was an optimal implant for the treatment of different type of intertrochanteric fractures [7–10]. PFNA is an intramedullary fixation system which allows early weight bearing postoperatively. The device permits impaction of the metaphyseal fracture through the sliding helically shaped collum-blade, which can accelerate the fracture union and reduce the incidence of femoral head penetration. Meta-analysis showed that PFNA had the benefits of less blood loss, minimal rate of fixation failure and shorter hospital stay compared with patients treated with Gamma nails, and dynamic hip screws [11,12].

So far, however, there was no prospective randomized study comparing PFNA with hemiarthroplasty for senile intertrochanteric fractures in the literature. Which method is better for treating these fractures in elderly patients remains controversial due to the insufficient clinical evidences. The purpose of this retrospective study

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was to compare the results of PFNA with hemiarthroplasty for senile intertrochanteric fractures.

2. Materials and methods

This study was approved by our institutional medical ethics committee and has been reported in line with the SCRE criteria [13]. The patients or their families were informed that data from the case would be submitted for publication, and obtained their consent. We reviewed all consecutive senile intertrochanteric fractures treated with PFNA or cemented hemiarthroplasty at our institution between July 2010 and March 2015. Patients aged ≥ 70 years and treated within 3 weeks after injury were included in the study. Pathologic fractures, multiple fractures treated with operation and those who lost follow-up were excluded. The chief doctors selected the treatment methods by their preference. If patients did not accepted the doctors' preferred choice, then the other treatment was selected. Before operation the patients and their families have been informed the choice of treatment, and all signed a consent form. The patients' baseline characteristics, operational data, the volume of concentrated red blood cells transfused, postoperative complications and rehabilitation program were obtained from the patients' medical records. Two authors independently collected the data. Discrepancy was resolved by discussion. The fracture type was classified according to the Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association (AO/OTA) classification. Bone osteoporosis was graded according to the Singh index [14].

2.1. Surgical methods

All operations were completed by two experienced orthopedic surgeons. Patients were given either general or spinal anaesthesia. All patients were administered prophylactic antibiotics 30–60 min before operation. The patients treated with PFNA were placed in the supine position on fracture traction table. The injured lower limb was put in straight and mild abduction with foot fixed in the boot on the traction device. After performed continuous mechanical traction, the limb was put at 10–15° adduction and rotation neutral position, then the state of reduction was checked by G-arm fluoroscopy, and was maintained by the traction device. Most cases of fractures achieved satisfactory reduction by this manipulations. If closed reduction was failed, a limited additional incision on the trochanter level was conducted without extensive exposure of fracture blocks, through which fracture reduction was completed with surgical instruments. PFNA was planted under G-arm fluoroscopy. After closed reduction, an about 5 cm longitudinal incision was made approaching to the femoral greater trochanter. A guide pin was drilled from the lateral aspect of the greater trochanter to the femoral medullary canal, and then inserted the nail through the guide pin. The collum-blade was located in the lower half of the femoral neck in the anteroposterior view and centrally in the lateral view and its tip reached nearly 5–10 mm to the subchondral bone of femoral head. A static locking screw was inserted under an aiming device.

Hemiarthroplasty was performed by using posterolateral approach with patients positioned in the lateral position. The femoral head and neck was taken out after the femoral neck osteotomy was done by oscillating saw. The femoral medullary canal was reamed to the appropriate size. A cemented stem and a bipolar head were used. The femoral stem was cemented into the femoral canal using the modern third-generation cementing technique. In case where the calcar was deficient, a longer femoral stem was selected. The hip center of prosthesis was placed at the height of the trochanter tip. Anteversion of prosthesis was guaranteed at 15–20° according to lateral condyle of femur and lesser

trochanter. The greater and lesser trochanter were reset and stabilized by using the tension band wiring technique. The external rotators were sutured to their anatomical locations.

2.2. Rehabilitation program

Patients were routinely given antibiotic prophylaxis for 48 h postoperatively. Low molecular heparin was given for two weeks as a mean of thromboprophylaxis. Patients were encouraged to do active and passive functional exercise from postoperative day 1. Patients with stable fractures treated with PFNA started partial weight bearing with a walker from 1 week after surgery; whereas those with unstable fractures started partial weight bearing 2–3 weeks postoperatively. Patients underwent hemiarthroplasty were encouraged to ambulate with support of a walker from postoperative day 2.

2.3. Follow-up and outcome measures

Patients were followed up at 1.5, 3, 6, 12 months for clinical and radiological evaluation after operation. Anteroposterior and lateral radiographs were performed to detect the fracture healing and implant-related complications. If the patients didn't come to hospital, the functional results were evaluated by telephone. The primary outcome measures were postoperative complications, reoperation rate and hip function. The postoperative complications were divided into orthopaedic complications and medical complications (occurred in hospital). The Harris Hip Score was used for functional evaluation [15]. The Harris Hip Score was divided into four grades: 90–100 were considered excellent; 80–89 were considered good; 70–79 were considered medium; and ≤ 69 was considered poor. The secondary outcome measures were intraoperative blood loss, transfusion rate, surgical time, postoperative hemoglobin, hospital stay and 1-year mortality. The surgical time of PFNA group was defined as from close reduction to complete the wound closure. The lowest value of hemoglobin in 5 days after operation was selected for comparison.

2.4. Statistical analysis

Statistical analysis was performed in Statistical Package for Social Sciences (SPSS) 20. Mean $\pm$ standard deviation or median value was reported for continuous variables. The Kolmogorov-Smirnov test was used to check the normality of distribution of continuous variables. If the continuous data were in accordance with Gaussian distribution, independent-sample *t*-test was used, and if the continuous data were not in accordance with Gaussian distribution, Mann-Whitney *U* test was used. Pearson chi-square test was used for the count data. A two-tailed *P*-value < 0.05 was considered to indicate statistically significance.

3. Results

Seventy-one patients in PFNA group and 52 patients in hemiarthroplasty group were included for analysis (Fig. 1). There was no significant difference in the comparison of baseline characteristics between PFNA and hemiarthroplasty group (Table 1).

There were significant differences between the two groups with regard to intraoperative blood loss, transfusion rate, postoperative HGB, time to partial weight bearing, and hospital stay (Table 2).

No statistically difference was observed between the two groups regarding to the Harris Hip Score at 1 year follow-up (81.3 ± 8.2 for the PFNA group and 79.1 ± 10.2 for the hemiarthroplasty group, $P = 0.240$, Table 3).

The incidence of orthopaedic complications was similar between the two groups (8.4% vs. 7.7%, $P > 0.999$, Table 3). In the

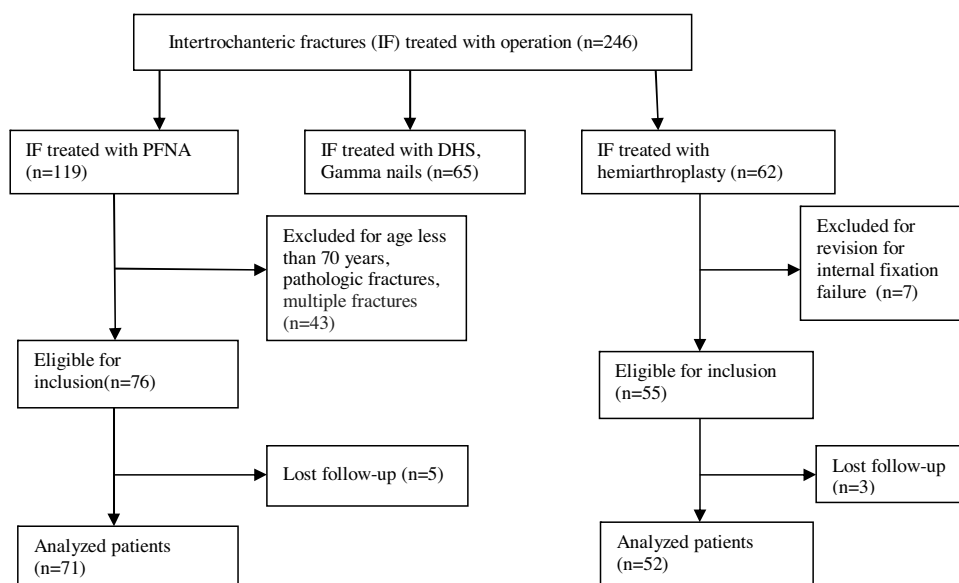


Fig. 1. Flow diagram of participants.

Table 1

The comparison of baseline characteristics between PFNA and hemiarthroplasty.

Characteristics	PFNA (n = 71)	Hemiarthroplasty (n = 52)	Statistic	P value
Gender: male/female	29/42	16/36	$\chi^2 = 1.313$	0.252
Age (years)	80.9 $\pm$ 6.5	81.3 $\pm$ 5.4	$t = -0.328$	0.744
Side: right/left	33/38	23/29	$\chi^2 = 0.061$	0.805
Follow-up (months):	24.9 $\pm$ 13.9	27.8 $\pm$ 13.7	$t = -1.152$	0.252
Singh's index grade: ≤ 3 / > 3	30/41	23/29	$\chi^2 = 0.048$	0.827
AO/OTA fracture classification			$\chi^2 = 0.137$	0.934
A1	25(35.2%)	19(36.5%)		
A2	35(49.3%)	24(46.2%)		
A3	11(15.5%)	9(17.3%)		
ASA grade			$\chi^2 = 0.49$	0.938
I	6(8.5%)	3(5.8%)		
II	50(70.4%)	37(71.2%)		
III	13(18.3%)	10(19.2%)		
IV	2(2.8%)	2(3.8%)		
Associated comorbidities				
Hypertension	32(45.1%)	22(42.3%)	$\chi^2 = 0.093$	0.76
Diabetes	16(22.5%)	6(11.5%)	$\chi^2 = 2.471$	0.116
Cardiovascular disease	4(5.6%)	6(11.5%)	$\chi^2 = 0.722$	0.395
Neurological disease	7(9.9%)	5(9.6%)	$\chi^2 = 0.002$	0.964
Pneumonia	2(2.8%)	3(5.8%)	$\chi^2 = 0.127$	0.721
Renal insufficiency	3(4.2%)	1(1.9%)	$\chi^2 = 0.039$	0.844
Time from injury to operation (days)	5.7 $\pm$ 3.4	6.5 $\pm$ 3.4	$t = -1.357$	0.177
Anaesthesia: general/spinal	23/48	20/32	$\chi^2 = 0.486$	0.486
Preoperative HGB(g/dL)	10.5 $\pm$ 1.7	10.5 $\pm$ 1.5	$t = -0.37$	0.97

PFNA Proximal femoral nail antirotation, HGB Hemoglobin.

Table 2

The comparison of outcomes between the two groups.

Variable	PFNA (n = 71)	Hemiarthroplasty (n = 52)	Statistic	P value
Surgical time (minutes)	80.0(10.0)	90.0(40.0)	U = 2175.5	0.089
Intraoperative blood loss (mL)	100.0(125.0)	300.0(200.0)	U = 3223.5	<0.001
Blood transfused ^a (mL)	200.0(400.0)	350.0(300.0)	U = 2705.0	<0.001
Postoperative HGB(g/dL)	9.0(1.3)	8.3(1.9)	U = 1223.0	0.001
Intraoperative transfusion rate	23/71(32.4%)	32/52(61.5%)	$\chi^2 = 10.714$	0.001
Postoperative transfusion rate	16/71(22.5%)	21/52(40.4%)	$\chi^2 = 4.547$	0.033
Time to partial weight bearing(days)	12.0(2.0)	5.0(3.0)	U = 126.5	<0.001
Hospital stay (days)	17.0(6.0)	19.5(7.5)	U = 2471.5	0.001

Continuous values are reported as mean $\pm$ standard deviation or median (IQR). HGB Hemoglobin.^a Volume of concentrated red blood cells.

Table 3
Functional outcome at 1 year follow-up.

Variable	PFNA (n = 66)	Hemiarthroplasty (n = 41)	Statistic	P value
Harris Hip Score (at 1 year)	81.3 ± 8.2	79.1 ± 10.2	$t = 1.138$	0.240
Harris grade				
Excellent	16(24.2%)	10(24.4%)	$\chi^2 < 0.001$	0.986
Good	34(51.5%)	17(41.4%)	$\chi^2 = 1.024$	0.311
Medium	12(18.2%)	10(24.4%)	$\chi^2 = 0.597$	0.440
Poor	4(6.1%)	4(9.8%)	$\chi^2 = 0.499$	0.480

Table 4
Postoperative complications, reoperation rate and mortality.

Variable	PFNA (n = 71)	Hemiarthroplasty (n = 52)	Statistic	P value
Orthopaedic complications	6(8.4%)	4(7.7%)	$\chi^2 = 0.000$	>0.999
Medical complications	4(5.6%)	9(17.3%)	$\chi^2 = 4.328$	0.037
Reoperation rate	2(2.8%)	1(1.9%)	$\chi^2 = 0.000$	>0.999
Mortality				
In-hospital	1(1.4%)	2(3.9%)	$\chi^2 = 0.075$	0.784
1 year	8(11.3%)	11(21.2%)	$\chi^2 = 2.246$	0.134

DVT Deep vein thrombosis.

PFNA group, 3(4.2%)patients had blade cut-out or migration. Of whom one underwent reoperation to remove the hardware system and performed hemiarthroplasty. One patient had the blade removal by local anesthesia, because the blade was back-out and lead to severe pain. The third patient had painful cut-out blade with poor functional result, but she refused to receive reoperation and never recovered to walk. Nail-break was found in 1 patient 4 months after operation. The fracture was healed 6 months after operation with good functional result. Nonunion occurred in 2 patients(2.8%). Of whom 1 had uremia 1 year after operation, and the fracture did not heal 2 years after operation. The other patient did not heal 8 months after operation and he was died 11 months after operation due to an attack of heart disease. In the hemiarthroplasty group, 4 patients had orthopaedic complications. Dislocation of prosthesis was occurred in 1 patients(1.9%)1 month after operation. The patient was bedridden and died due to pulmonary infection 3 months after operation. Aseptic loosening of the femoral component was recognized in 1 patient who had severe pain in the thigh with poor functional results, but he did not take any further operation due to his fragile condition. Nonunion of greater trochanter fracture block occurred in 1 patient with moderate pain. One patient treated with hemiarthroplasty had superficial wound infection which was cured after a debridement and wound dressing. There was no significant difference between the two groups with regard to the reoperation rate(2.8% vs. 1.9%, $P > 0.999$, Table 3).

The incidence of medical complications in hemiarthroplasty group was significantly higher than that in PFNA group (17.3% vs. 5.6%, $P = 0.037$, Table 4). Pneumonia was the most common complication in the hemiarthroplasty group which account for 56% of its total medical complications. Patients treated with hemiarthroplasty had a trend of higher postoperative 1-year mortality compared to those underwent PFNA (21.2% vs. 11.3%). However, there was no significant difference between the two groups.

4. Discussion

Treatment for senile intertrochanteric fractures, especially those unstable fractures with severe osteoporosis, remains a challenge. Some studies reported that hip arthroplasty in treating these fractures had more advantages than internal fixations [4,16–19]. However, the findings of the present study did not support hemiarthroplasty as a preferred choice when compared with PFNA.

One advantage of primary arthroplasty in treating these fractures is to avoid the postoperative complications caused by internal fixation failure [5]. Nevertheless, in the present study, no significant difference was observed between the two methods concerning orthopaedic complications and reoperation rate. In another retrospective study, Tang et al. [20] showed that the incidence of complications were higher in hemiarthroplasty group than in PFNA group (14.1% vs. PFNA 8.96%), without statistically difference. PFNA had been approved to be an effective method in treating unstable senile intertrochanteric fractures with low rates of internal fixation failure and related reoperation [21,22]. The results of the present study also testified this opinion. Although many studies indicated that hemiarthroplasty in treating these fractures had very low incidence of postoperative complications [3,16,17,23,24], the complications of hemiarthroplasty, such as prosthetic dislocation, prosthesis loosen and cement reaction, can not be completely avoided, which are mainly depended on the skill level of the operating surgeon. The procedures of hemiarthroplasty in treating intertrochanteric fracture are much more complicated than in treating femoral neck fracture, especially in case of comminuted intertrochanteric fracture, of which more sophisticated techniques are needed to ensure proper installation of the prosthesis. In view of the minimal rate of fixation failure and reoperation rate of PFNA, we believe that routinely choosing primary arthroplasty to treat senile intertrochanteric fractures is not recommended.

It is well know that early ambulation can reduce the incidence of pressure sores, pulmonary infection and improve the functional outcome. However, we found that patients treated with hemiarthroplasty were associated with higher incidence of medical complications (17.3%), of whom 9.6%(5/52) developed pneumonia, even they had earlier weight bearing time than those treated with PFNA. We considered several reasons possibly contributed to this result. On the one hand, the massive intraoperative blood loss and the higher perioperative blood transfusion rate indicated that the invasiveness of hemiarthroplasty was greater than PFNA, which caused serious blow to the fragile body, and making patients venerable to infections. On the other hand, in PFNA group, the minimally invasive procedures led to less physiological disturbances on the patients. Those who underwent PFNA recovered their physical function quickly and carried out early partial weight bearing with a walker, thus reduced the recumbency related complications. In addition, although hemiarthroplasty resolved the hip fractures problem and created opportunities for early walk, some patients

because of too fragile body could not recover their ability to walk as early as doctors expected. As Pho RW et al. [25] and Siwach R et al. [26] reported that only 75–88% of patients treated with hemiarthroplasty could successfully ambulate.

Theoretically, patients treated with hemiarthroplasty can obtain better functional recovery than those treated with PFNA in the first few months after surgery. Nevertheless, the functional results were significantly affected by other factors, such as age, gender, health status, social dependency before fracture, and post-operative complications [26]. In the present study, at 1 year follow-up, there was no statistically difference between the two groups regarding to the Harris Hip Score (81.3 ± 8.2 for the PFNA group and 79.1 ± 10.2 for the hemiarthroplasty group, $P = 0.240$). Tang et al. [20] reported that at 3 years follow-up, there was no significant difference in Harris Hip Score between PFNA and hemiarthroplasty group (83.0 ± 12.2 for the PFNA group and $80.2.1 \pm 10.9$ for the hemiarthroplasty group, $P = 0.09$), but significant difference was found in the rate of the excellent-to-fine functional results (PFNA 90.2% and hemiarthroplasty 79.6%). Özkayın N et al. [27] conducted a prospective randomized study comparing PFN with hemiarthroplasty for intertrochanteric fractures in the elderly, and found that at 3 months, Harris Hip Score average was 45.24 in PFN group and 63.38 in hemiarthroplasty group respectively, with significant difference; while at 12 months, Harris Hip Score average was 75.95 in PFN group and 68.44 in hemiarthroplasty group respectively, with significant difference. It seems that intertrochanteric fractures treated with PFNA may achieve better functional results than treated with hemiarthroplasty in the middle and long term, however more long term follow-up studies are needed to confirm it.

Senile intertrochanteric fractures were associated with high mortality and morbidity. Some previous studies had compared the mortality between hemiarthroplasty and internal fixations with no consistent results. The 1-year mortality of senile intertrochanteric fractures treated with hemiarthroplasty ranged from 12.2 to 35% [6,28]. Kim SY et al. [29] conducted a small sample size prospective randomized study comparing cementless hemiarthroplasty with PFN for unstable intertrochanteric fractures and reported that the mortality at 1-year was 27.6% in hemiarthroplasty group and 13.8% in PFN group, without significant difference. Nevertheless, Tang et al. [20] reported that patients treated with hemiarthroplasty had a significantly higher mortality than those treated with PFNA at 1-year (23.1% vs. 13.1%) and 3-year (34.0% vs. 20.1%). In the present study, we found a trend of higher 1-year mortality for patients who underwent primary hemiarthroplasty compared with those underwent PFNA (21.2% vs. 11.3%, $P = 0.134$). One potential reason of leading to higher mortality in patients treated with hemiarthroplasty was the relative greater surgical trauma that hemiarthroplasty brought to the aging patients.

The present study has several limitations. First, it was a retrospective control study. Despite similar baseline characteristics in each group, the selection bias could not be excluded. Because the ambulatory ability before injury was impossible to compare, whether it was distributed balanced between the two groups was unclear, which could lead to bias to the comparison of postoperative functional results. Second, the follow-up time was relatively short. The implant-related complications occur usually in the first year after operation in patients treated with PFNA, while increase with time in patients treated with hemiarthroplasty. To compare the implant-related complications of the two methods long term follow-up studies are needed. However it is very difficult to conduct a long term follow-up study due to the high mortality in the aging patients. Third, the sample size was not large. We found a trend of higher postoperative 1-year mortality in hemiarthroplasty group than in PFNA group, while the statistics did not detect significant difference between them. Based on a mortality difference of 10 percent in a previous study [20], the sample size of 155 patients

in each group was required to detect the difference with a power of 80 percent and a type I error of 5 percent.

In summary, the results of this retrospective study showed that there were no significant differences between the two groups with regard to the orthopaedic complications, reoperation rate, surgical time and Harris Hip Score at 1 year follow-up. PFNA has obvious advantages over hemiarthroplasty in the treatment of senile intertrochanteric fractures. Hemiarthroplasty in treating these fractures is associated with greater surgical trauma and higher incidence of postoperative medical complications.

Conflict of interest

None.

Funding

We have no any sources of funding for our research.

Ethical approval

The study was approved by the medical ethics committee of Zhujiang Hospital, Southern Medical University. (ID number, 2015-GKZX-004).

Consent

The patients or their families were informed that data from the case would be submitted for publication, and obtained their consent.

Author contribution

Xiangping Luo contributed for the study design, data collection, data analysis and writing.

Qi Li and Lijun Lin, the operating surgeon.

Shengmao He, assisted for the operation and data collection.

Dingshi Zeng contributed for the study design, data analysis and proof read.

Registration of research studies

Researchregistry1681.

Guarantor

Xiangping Luo.

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