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Effect of introducing early weight bearing training in rehabilitating patient with tibial plateau fracture fixed with open reduction internal fixation.

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There is lack of evidence supporting early weight bearing in physical therapy treatment programs after open reduction and internal fixation of fractures. Up to our knowledge there is no published work performed to investigate the effect of adding early weight bearing to the protocol of treatment after open reduction internal fixation surgeries of tibial plateau fracture. Thirty patients diagnosed with tibial plateau fractures Schatzker type II fixed by locked buttress plates with sub-articular screws were referred from orthopedic surgeons after the operation, their ages ranged from 25-45 years. The patients were included in the study if they have a diagnosis of tibial plateau fractures Schatzker type II fixed by locked buttress plates with sub-articular screws, age ranges from 25-45 years. Patients were randomly assigned into two groups. Group A treated with physical therapy program with introducing early weight bearing training. Group B treated with physical therapy program and delayed weight bearing training. Criteria for progression were based on surgeon judgment, pain level, condition of surgical site and strength of the lower extremity. The outcome measures were: Digital X-ray to assess the fracture stability pre-and post-treatment, visual analogue scale to assess pain level and fluid-filled inclinometer to measure the ROM during rehabilitation. RESULTS: There was no significant difference between groups regarding fracture stability (pre-p=1,00 and post p=.0599) and ROM measurement pretreatment (p=.325) post treatment (P=0.095), and there was no significant difference between groups in pain intensity level (VAS) pre (p=.60) and post treatment (p=.192). There was a significant difference between pre-and post-treatment within group A regarding (VAS, P=0.0001) and (ROM, P=0.0001) and group B regarding (VAS, P=0.0001) and (ROM, P=0.0001). there was significant difference regarding fracture stability within group A (P=0.0001). and within group B regarding fracture stability (P=0.0001). Based on the results, early weight bearing treatment approach of tibial plateau fractures fixed with locked buttress plates with sub-articular screws can be a cost-effective approach for treatment. This study can serve as a guidance for the clinicians who are dealing with this category of orthopedic patients to avoid complication of delayed weight bearing.

Keywords: Early weight bearing, Tibial plateau fracture, Rehabilitation.

INTRODUCTION

Lower extremity fractures are among the most common conditions treated by orthopedic

surgeons and making appropriate recommendations regarding weight bearing is an important clinical issue as it may improve function

and speed of return to work, thus minimizing the economic impact of an injury (Kubiak,2013).

Tibial plateau fractures can occur because of high-energy trauma or in low-energy trauma when bone quality is poor. The most common mechanism of injury is motor vehicle accident, followed by falls and sports injuries, with 40% of injuries being poly-trauma. The mean age of people with this type of fracture is 50. This type of fracture can occur in both younger and older patients, however usually have different etiology (Schatzker et al,1979) and (Segal et al., 1993).

The rehabilitation of patients with a lower extremity fracture is a transition from initial complete dependency to recovery of optimal functional status. The most important aspect of post-operative management is early mobilization, to prevent the complications associated with recumbency and bed rest. The ability to walk within two weeks postoperatively is a verification of good quality of surgery with no complication. As a matter of fact, in one of the early series the walking ability within two weeks postoperatively was more prognostic than the pre-fracture walking ability for early return to home (Ceder,2005).

Treatment of proximal tibial fractures is challenging. Patient recovery depends on optimal joint congruency, fracture alignment rotation and postoperative complications such as joint stiffness, arthritis instability and pain. Additionally, treatment can be complicated by cartilage and soft-tissue injury, compartment syndrome and infection (Lachiewicz and Funick 1990).

Immediate postoperative weight-bearing is traditionally not recommended following treatment of proximal tibial fractures due to fear of fracture collapse, especially at the articular surface. However, the use of new anatomical shaped locking plates with several sub-articular screws has made it possible to obtain a more stable fracture fixation than with conventional methods. Greater loading forces may therefore be allowed (Stannard et al., 2008), (Ehlinger et al., 2010), (Biggi et al., 2010) and (Oh and Hwang 2010).

Immediate weight-bearing and mobilization could potentially reduce the risk of postoperative complications such as deep venous thrombosis and more rapidly secure recovery to a pre-fracture ambulation level. If early mobilization does not increase the risk of fracture collapse or compromise outcome, this treatment regime would therefore be attractive (Boldin et al., 2006).

The decision of allowing patient to start weight bearing training was based on the individual surgeon's judgment. There are factors that help

surgeons to talk this decision as body mass index, age, bone quality, cognitive impairment, level of mobilization before fracture and patient compliance. fracture complexity, the operative result in terms of fracture reduction and achieved stability of fixation, surgeon and departmental routines influence the decision also (Haak et al., 2012).

Introducing immediate weight bearing to the rehabilitation of patients with femoral and tibial shaft fractures fixed with implants like intra medullary nails is well documented and there are many research works have been supported this issue, although there are no studies focused in using immediate weight bearing as a treatment protocol for tibial plateau fractures fixed with plate and screws. There are no studiers focused on how many percent of weight the patient can use to start weight bearing training and there are no studies with Hight level of evidence explained how the fracture stability differs after introducing immediate Wight bearing after tibial plateau fracture fixed with internal fixation.

As There is lack of evidence supporting adding early weight bearing in physical therapy treatment protocol after tibial plateau open reduction and internal fixation of fractures, we performed this series to study the effect of early and late weight bearing after tibial plateau fractures fixed by locked buttress plates with sub-articular screws.

MATERIALS AND METHODS

Thirty patients diagnosed with tibial plateau fractures Schatzker type II fixed by locked buttress plates with sub-articular screws were referred from orthopedic surgeons after the operation, their ages ranged from 25-45years., and their Body Mass Index (BMI) ranged from 25-29.9 Kg /M2. A consent form signed by the patient was collected from each patient before entering the study.

This study was approved by ethical committee for scientific research at the faculty of physical therapy, Cairo university. It was performed at Cairo university's educational hospital at the in-patient departments of orthopedics and it was in the period between October 2014 to September 2016. Patient allocation to groups was randomized by using sequentially numbered opaque envelopes. Group A patients were treated with suggested early weight bearing program and group B patients treated with delayed weight bearing program.



Figure (1) Pretreatment for early weight bearing group x ray image

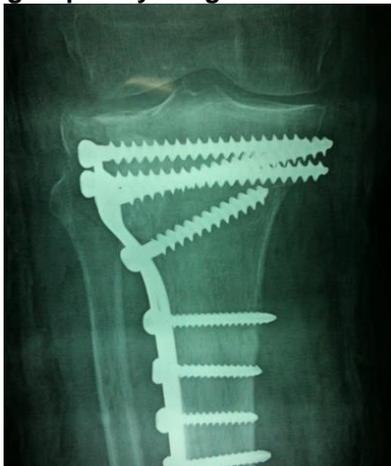


Figure (2) Post treatment for early weight bearing group x ray image

The patients were included in the study if they have a diagnosis of tibial plateau fractures Schatzker type II fixed by locked buttress plates with sub-articular screws, age ranges from 25-45 years, and their Body Mass Index (BMI) ranged from 25-29.9 Kg /M². Patients were excluded if they have previous hip or lower extremity surgeries, pathological conditions of the lower extremities e.g. tumors, infections, and other systemic diseases e.g. Diabetes, rheumatoid arthritis and any neurological diseases.

Group A (15 patients with mean age 28.76±7.39) who received 24 sessions of conventional physical therapy program (two sessions per week for 12 weeks) which included (respiratory exercises, ROM, static quadriceps exercises, strengthening exercises. All exercises were performed in 3 sets, 5 repetitions each) plus

an early weight bearing exercise program which started on postoperative day 3.

The patient received full instruction about the rehabilitation program, sequences of progression through the process and the suspected side effects or complications. All of them could stop participation in research methodology at time they want with the continuation of treating them with traditional program. We used stationary digital scale (Fig 4) to weight every patient before surgery then we educated them about how to weightbearing at the scale with desired percentage of their weight.

During the first session after doing exercises each patient was assisted to set at edge of the bed and with using two crutches they started to press on the scale with the required percentage of weight, we started with 10 % of the patient weight at first week, then they were assessed to stand catching both crutches and supporting on the sound leg then they were asked to repeat pressing on the scale using the same percentage. After we were satisfied that each patient can tolerate the required weight they could walk for few steps and they could rest. During the entire two week we were repeating the weightbearing training and we allowed them to use this percentage during daily activities. After two week they should progress to higher percentage of weightbearing. We standardized a progression criteries that were used to judge the situation and allow patient to progress to second level of increasing percentage of weight bearing, those criteria were surgeon judgment, pain level, condition of surgical site and strength of the lower extremity

During the 3rd and 4th week the patients could introduce 20 % of weight during weight bearing training and we were training the patient with the same Wight during the whole two weeks and we allowed them to use the same percentage during their daily living activates. Then we were progressed to use 30 to 40 % percentage of weight during 5th and 6th week. After the six week we performed A/P view to follow up the fracture fixation and healing process and the surgeons were in direct contact to chik the fracture status and confirm the continuation of the rehabilitation program.

During the 7th and 8th week the patient could introduce up to 60 % of their weight on the affect leg during walking with cutches and by the start of 9th and during the10th week they could weight bear as tolerated on their affected leg during walking with crutches and by the 12th they were

off crutches and they could weight bearing on both legs and they allowed to walk as normal sequences.



Figure (3) Measurement of fragment migration using eFilm Workstation™ 3.1 (Merge eFilm, Milwaukee, WI, USA).



Figure 4 digital scale for weight bearing training



Figure 5 fluid filled inclinometer for ROM assessment

After the 12th week were performed X- ray imaging to assess the status of the fracture fixation.

Group B patient have been received the same conventional treatment as in group A, plus a delayed weight bearing program. The patients could walk using both crutches without weight bearing on the affected leg for six weeks (non-weight bearing walking) then after the six week and after taking X ray imaging they allowed to weight bear on their affected limb.

The patients could partial weight bear to their affect leg which was less than 50 % of their total body weight but we didn't use scale for this purpose. Then they could introduce weight bearing as tolerated during walking on the affected leg during 9th and 10th weeks. At 11th and 12th weeks they were using full weight bearing on their affected leg without crutches. The outcome measures were: Digital X-ray to assess the fracture stability pre-and post-treatment, visual analogue scale to assess pain level and fluid-filled inclinometer to measure the ROM during rehabilitation.

Range of Motion assessment:

Fluid filled inclinometer (Fig 5) has been used for this assessment and it was performed initially post-operative and after 12th week. Patient position assumed supine lying position and the inclinometer will be at anterior surface of lower part of tibia then patient will be instructed to actively flex his knee as much as he can.

Radiographic evaluation:

Radiographic evaluations have been done immediately postoperative fig (1), 6 weeks and 12 weeks fig (2) after the operation. We introduced the base line measurement and 12 weeks post-operative at statistical assessment. The axial migration of the fragments has been measured using a specified method, which included digitization of the radiographs by e film workstation, X-ray images introduced to e Film Workstation™ 3.1 (which is the latest version of the widely-used desktop diagnostic imaging software available via download. An easy to use DICOM Viewer used in thousands of hospitals) to assess the fragments stability depending fig (3). We measured the distance from the top of the tibial plateau to corresponding articular surface of femur by using threes references points as shown in fig (3). X-ray imaging studies were performed at 6th week to assess the fracture fixation and stability by the surgeons, but we didn't include them in the statistics in this study.

The vertical distance between the three points have been calculated on each film and the difference between initial x-ray and last x-ray has been considered as a measure of the subsidence of the fracture fragment. Two different sets of readings were made on each digitized film by a single observer. The immediate postoperative and last follow-up X-rays, the 12th week, have been evaluated. Anteroposterior films of the involved tibia were assessed along with clinical follow-ups. All outcomes measurements were assessed at base line immediately post-operative and 12 weeks post-operative.

Statistical analysis:

The statistical analysis was conducted by using statistical SPSS Package program version 20.0 for Windows (SPSS, Inc., Chicago, IL). Descriptive statistics including the mean and standard deviation for age, pain, ROM, migration. The following statistical procedures were conducted:

Chi-square test to compare between groups A and B for sex distribution and Paired t-test to compare variables within each group (pre and post measurements) for tested variables (pain, ROM, migration). Independent (unpaired) t-test to compare between groups 1 and 2 for age and the tested variables (pain, ROM, migration).

RESULTS

The current study evaluated the effect of early and late weight bearing after tibial plateau fractures fixed by locked buttress plates with sub-articular screws. Prior for final analysis, data were screened, for normality assumption test and homogeneity of variance. Normality test of data using Shapiro-Wilk test was used, that reflect the data was normally distributed after removal outliers that detected by box and whiskers plots. All these findings allowed the researchers to conducted parametric and non-parametric analysis.

Table [1] represent the mean values of age and sex between groups A and B. The mean of age for were 33.40 ±4.35year and 33.50 ±3.70year, for groups A and B, respectively. The results revealed that there was no significant difference between groups according to demographic data including age and sex.

Out of a total of 30 patients, three patients (1 in the group A, 2 in group B) were excluded from the study, one patient demonstrated fixation failure in group A and underwent a revision.

Table (1): Comparison of physical characteristics between groups A and B.

Items	Age (year)	Gender	
		Male	Female
Group A	34.33 ±9.43	8 (53.33%)	7 (46.67%)
Group B	33.90 ±7.02	9 (60.00%)	6 (40.00%)
P-value	0.887	0.713	
Significance (P<0.05)	NS	NS	

Table (2): Comparison mean values pre and post-3M of pain within each group.

Items	Pain			
	Group A		Group B	
	Pre	Post-3M	Pre	Post-3M
Mean ±SD	7.83 ±0.83	1.67 ±0.72	8.50 ±0.70	1.37 ±0.48
Improvement %	78.67%		83.88%	
t-value	18.305		43.172	
P-value	0.0001		0.0001	
Significant	S		S	

Two patients missed the follow up in group B as they were absent during follow-up. So, 27 patients were included in the final outcome analysis.

The statistical analysis of paired t test revealed that there were significant differences among pre and 3M post-operative treatment of pain within group A (P=0.0001; P<0.05) and group B (P=0.0001; P<0.05) the mean values of pain for group A were (pre 7.83 ±0.83 and post 1.67 ±0.72) and for group B were (pre 8.50 ±0.70 and post 1.37 ±0.48). The statistical analysis of unpaired t test revealed that there were no significant differences between both groups regarding pain variable, mean values of pre-treatment (P=0.620; P>0.05) and 3M post (P=0.192; P>0.05). The Mean values of pre-pain values were 7.83 ±0.83 and 8.50 ±0.70 for group A and B, respectively. Mean values of post-3M pain values were 1.67 ±0.72 and 1.37 ±0.48 for group A and B, respectively.

For ROM variable the results revealed that there were significant differences among pre and 3M post-operative treatment of knee ROM within group A (P=0.0001; P<0.05) and within group B (P=0.0001; P<0.05). mean values of ROM were (pre 9.00 ±3.87 and post 111.33 ±8.12) for group

A and (pre 7.60 ±3.77 and post 116.00 ±6.60) for group B which indicating improving in knee function level and in comparison between groups the unpaired t test revealed that there were no significant differences in knee ROM mean values of pre-treatment (P=0.325; P>0.05), post-3M (P=0.095; P>0.05) between both groups. Mean values of pre-ROM were 9.00 ±3.87 and 7.60 ±3.77 for group A and B, respectively. Mean values of post-3M ROM were 111.33 ±8.12 and 116.00 ±6.60 for group A and B, respectively.

Also paired t test statistics revealed that there were significant differences among pre and 3M post-operative treatment of Migration within group 1 (P=0.0001; P<0.05) as the mean values of migration were (pre 0.98 ±0.11 and post 1.15 ±0.14) and within group 2 (P=0.0001; P<0.05) as mean values were (pre 0.98 ±0.11 and post 1.13 ±0.13). There were no significant differences in migration mean values of pre-treatment and post treatment between groups as for pre (P=1.000; P>0.05) and post-3M (P=0.599; P>0.05) as Mean values of pre-migration were 0.98 ±0.11 and 0.98 ±0.11 for group A and B, respectively. Mean values of post-3M migration were 1.15 ±0.14 and 1.13 ±0.13 for group A and B, respectively.

Table (3): Comparison mean values pre, post-3M pain between groups A and B.

items	Pre	Post-3M
Group A	7.83 ±0.83	1.67 ±0.72
Group B	8.50 ±0.70	1.37 ±0.48
t-value	1.355	1.337
P-value	0.620	0.192
Significant	NS	NS

Table (4): Comparison mean values pre and post-3M of ROM within each group.

Items	ROM			
	Group A		Group B	
	Pre	Post-3M	Pre	Post-3M
Mean ±SD	9.00 ±3.87	111.33 ±8.12	7.60 ±3.77	116.00 ±6.60
Improvement %	1159.22%		1426.32%	
t-value	42.929		59.475	
P-value	0.0001		0.0001	
Significant	S		S	

Table (5): Comparison mean values pre, post-3M ROM between groups A and B

Items	Pre	Post-3M
Group A	9.00 ±3.87	111.33 ±8.12
Group B	7.60 ±3.77	116.00 ±6.60
t-value	1.002	1.727
P-value	0.325	0.095
Significant	NS	NS

Table (6): Comparison mean values pre and post-3M of migration within each group.

Items	Migration			
	Group A		Group B	
	Pre	Post-3M	Pre	Post-3M
Mean ±SD	0.98 ±0.11	1.15 ±0.14	0.98 ±0.11	1.13 ±0.13
Improvement %	17.35%		15.31%	
t-value	7.597		5.735	
P-value	0.0001		0.0001	
Significant	S		S	

Table (7): Comparison mean values pre, post-3M migration between groups A and B.

items	Pre	Post-3M
Group A	0.98 ±0.11	1.15 ±0.14
Group B	0.98 ±0.11	1.13 ±0.13
t-value	0.000	0.532
P-value	1.000	0.599
Significant	NS	NS

Table n2 to 7 are not sighted in text

DISCUSSION

The orthopedic surgeons were recommending non-weight bearing protocol after tibial plateau fracture fixation. Those protocols encourage the patients to stay in bed for long time and this resulting in many complications on their body. The most common used protocol was to avoid weight bearing for 6 weeks (Haak et al., 2012). Some authors suggested that it is not applicable for the patients to completely avoid any contact between the affected limb and the ground. Hurkmans and his coworkers concluded that the patients routinely exceeded the prescribed amount of partial weight bearing, even when they were closely observed in a laboratory setting. As tibial plateau surgeries become more updated and has been changed greatly, surgeons recently used sub chondral screws in fixing such fracture (Hurkmans et al., 2006). Sub chondral screws add more support to tibial articular surface and decrease the chance of collapse than with conventional methods and this new method give the surgeons the chance to allow their patients to accept immediate weight bearing after surgeons (Oh et al., 2010) and (Stannard et al., 2008).

So, thinking about introducing early weightbearing intervention for those patients was mandatory to improve their functional level and avoid the extreme hazards of bed ridden and bed recumbency. Patients accept the concept of early mobility for a satisfactory level and they were fighter and cooperated with the team strongly to achieve the goals efficiently. The review of literature supported the use of early weight bearing for common Tibial fractures as shaft fracture, as revealed in the study of Kershaw et al., 1993 and Joslin et al., 2008 in which they introduce immediate weight bearing after external fixation of tibial shaft fractures and gained good results. The study of Adam et al., 2012 investigated introducing early weight bearing as tolerated for tibial shaft fractures that were managed with minimally invasive locked bridge plating; immediate weight bearing was allowed as

tolerated and the results revealed good functional outcomes.

Early weight bearing training becomes a pillar in rehabilitation protocols for different fracture treatment with intramedullary nails and dynamic screws and there were a visible and growing literature supporting this issue. Brumback and his colleges provided a series including 28 patients with comminuted diaphyseal femur fractures (i.e., Winquist types III and IV) treated with reamed IM nailing utilizing a statically locked 12-mm nail. They permitted the patients to bear weight as tolerated immediate post operatively and progressed to full weight bearing by 6 weeks which was a very short time. All fractures united; only one of these needed an additional procedure (the removal of the screws five months after the insertion of the nail) to stimulate union. No fixation failure, occurred. They concluded that the patients can make benefit from immediate weight bearing training and possibly decreasing the duration of the hospital stay (Brumback et al., 2007).

On the same way, Ariza and his coworkers treated 30 patients with comminuted diaphyseal femur fractures (i.e., Winquist types II, III, and IV) treated with statically locked reamed intramedullary nailing. They allowed the patients to immediately weight bear on the affected limbs by one to two-week post operatively then they progressed to full weight bearing with assistive device by the second month post operation. All fractures healed without complication. but there was slight bending in one distal interlocking screw and one proximal interlocking screw. The fractures of the patients with bent screws healed uneventfully. No construct failures were reported (Arazi et al., 2001).

For critical fractures like tibial plateau it is very challenging to introduce early mobility for those cluster of fracture after open reduction internal fixation (ORIF) surgeries and the literature is very scarce about rehabilitation of this fracture. So current study tried to suggest a standard rehabilitation protocol including early weight bearing strategy based on a standard method. The results of this works according to pain level

and knee joint ROM were accepted with the results of Segal and his colleges and this study tried also to break down the rocky concept of post ponding weight bearing and provide a favor for introducing the partial weightbearing as much as early, Also this study comes in the same way of our results according to fracture stability (Migration) as they conclude that early weight bearing may not carry the risk of fracture displacement that is traditionally presumed (Segal et al., 1993).

Karl and his colleges Used digital x ray for assess the implication of immediate weightbearing after tibial plateau osteosynthesis. Per-articular tibial fracture patients were included in this study and they were divided into two groups, one received weightbearing after 6 weeks and the other one started weight bearing immediately post operatively.

The results of this study according to pain and ROM variables matches the results of current one and x rays images post-operative in comparison with pre-one revealed no significant change in fracture stability of those patients which also proves our results according to fracture migration variable, as our study revealed that there was no significant difference between pre and post treatment of both groups. We should take care that the type of fracture included in Karl's study was totally different as it is not considered intra articular fracture in compare with Schatzker fracture, but the study was concerning with the same aim of our study and assessed almost the same effect on knee function and fracture stability after adding immediate weight bearing (Karl et al., 2012).

Results of current series revealed that there was no significant difference between both groups related to fragment stability which favors use the early weightbearing protocol and avoid negative effect of delaying it since both are equal. This result approved by Solomon and his colleges as their trial include early weight bearing for similar subjects, they were seven patients with Schatzker type II tibial plateau fractures managed with subchondral screws and locking plate fixation. The patients were permitted to add partial weight bearing (20 kg [44 lb.]) to the affected leg during walking during the first 6 weeks postoperatively and then were instructed to progress to full weight bearing as tolerated. They used Radio stereometric analysis for assessment and follow up of fracture stability. They concluded that the measurements revealed that the fracture were stable after the treatment plane which comes in

agreement with our series results. Solomon's series was direct related to our work in facts, but it was a case series which has been performed on seven patients only (Solomon et al., 2011).

Kubiak in his review article published in 2013 suggested a recommendation of weight bearing strategies for different fractures all over the lower limb such as femur, tibia and ankles. Those recommendations including both percentage of weight bearing and when to start. For tibial plateau region he made his suggestion depending on the study of Segal et al., in which they used Nonlocked buttress plate for Schatzker I–III and the study of Haak and his colleges locked buttress plate for Schatzker I–IV and the cases series of Solomon's and his coworkers and the results were satisfiable for him and it also in riches the literature of support to use early weight bearing for tibial plateau (Kubiak et al.,2013). There are limitations in current study including small sample size, a separated control group is missed in this study. Also reference points of X-ay measurement are different from one patient to another. Further studies are needed to assess the long-term effect of early weight bearing after tibial plateau fracture fixation, also studies needed to assess the effect of tibial plateau structural changes after early weight bearing protocols. Bigger sample size studies also recommended to improve the validity of using such protocol. This study has been performed without any conflict of interest.

CONCLUSION

Based on the results, early weight bearing treatment approach of tibial plateau Schatzker two fractures fixed with locked buttress plates with sub-articular screws can be safe and cost-effective approach for treatment. This study can serve as a guidance for the clinicians who are dealing with this category of orthopedic patients to avoid complication of delayed weight bearing.

CONFLICT OF INTEREST

This study has been performed without any conflict of interest.

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AUTHOR CONTRIBUTIONS

SK and AK were responsible for surgical procedures, follow up of the patient and approve the progression of weightbearing after each stage. AK took all consent forms from the patients. AB and LA were supervisor during rehabilitation procedure. MM were Applying the physical therapy sessions and help patient during early and late weight bearing training. SK, AK,LA and MM designed experiments and reviewed the manuscript. All authors read and approved the final version.

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