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Long-term outcome in operatively and non-operatively treated isolated type B fibula fractures

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ABSTRACT

Purpose: Type B fibula fractures are the most common type of ankle fractures. Generally, surgical repair is advised for unstable fractures and non-operative treatment for stable fractures. However, evidence on long-term functional outcome of both treatment regimens is lacking.

Aim of this study is to compare the long-term outcome in function and pain between patients with an isolated type B fibula fracture treated non-operatively and surgically.

Material & methods: In this retrospective cohort study, all consecutive patients aged between 18 and 75 years, treated non-operatively or surgically between January 2008 and December 2015 for a distal fibula fracture at the level of the syndesmosis without an additional medial or posterior fracture and with a medial clear space ≤6 mm were included. All eligible patients received a questionnaire, composed of the Olerud-Molander Ankle Score (OMAS), the American Orthopaedic Foot and Ankle Society ankle-hindfoot score (AOFAS), the Euroqol-5D (EQ-5D) for quality of life and the Visual Analogue Scale (VAS) for pain sensation.

With a mean follow-up of 5.3 years, 229 patients were included. For all aspects of the questionnaire, there was no significant difference between non-operative and operative treatment in outcome of function and pain: the EQ-5D score was respectively 0.8 vs. 0.9 ($p = 0.72$), mean VAS score 0.8 vs. 1.3 ($p = 0.09$), OMA score 84 vs. 84 ($p = 0.98$) and for the AOFAS 93 vs. 90 ($p = 0.28$). 33% of the patients who had surgery had revision surgery for implant removal because of persistent pain complaints. In 3% of the surgically treated patients, a wound infection required intravenous antibiotic treatment. In the non-operatively treated cohort, one patient developed a deep venous thrombosis in the fractured leg.

Conclusion: According to results of this study, in adult patients with an isolated distal fibula and medial clear space ≤6 mm, without proven instability these fractures can safely be treated non-operatively, while avoiding risks and costs of surgery and preserving good long-term outcome in terms of pain and function.

Introduction

Ankle fractures are one of the most common fractures encountered in the hospital, representing 10% of all fractures [1]. The most common type is the isolated transsyndesmotic (type B) fibula fracture [1].

In current literature, consensus has been reached that a type B1 fracture, without additional medial or posterior injury and thus stable, can be treated safely non-operatively [3-5]. On the contrary, in case of a distal fibula fracture combined with a medial fracture or deep deltoid ligamentous injury the talus is more likely to lateralise and thereby form an incongruent ankle joint. Anatomical reduction and fixation of the fibula fracture have, in these cases, been found to yield better results [2].

The mortise radiograph is the most commonly used diagnostic tool to differentiate between stable and unstable fractures. In case of a medial clear space (MCS) ⟨4 mm the fracture is considered stable and generally non-operative treatment is advised. According to most studies, a MCS of ⟩6 mm or a MCS > superior clear space (SCS) + 2 mm is suggestive of a total tear of the deep deltoid ligament (DDL) [5,6]. In healthy patients, these fractures are generally treated surgically. For B-type fractures with a MCS 4–6 mm on the mortise view, additional diagnostics are advised to differentiate between a stable and unstable ankle fracture and thereby choice of treatment. With definite exclusion of medial injury, based on the additional diagnostics, these fractures also may be treated non-operatively [7].

However, a recent national online survey among 182 trauma- and orthopedic surgeons in the Netherlands revealed that surgi-

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cal management is preferred by 30% of the surgeons in case of MCS > 4 mm or a fibula dislocation >2 mm - even without additional diagnostic information about the medial ligament [8]. However, in a substantial number of radiographs with a MCS widening >4 mm, the DDL is still (partially) intact [9]. Probably, many type B fractures are incorrectly diagnosed as unstable and therefore many patients undergo unnecessary surgery. This surgery is associated with costs and risks. Not only the risks of the anesthesia, but also infection, venous thromboembolism, failure of fixation and the need for revision surgery are risks that the surgeon and patient should be aware of Soohoo et al. [10].

Moreover, the average costs of surgical and non-surgical management of an isolated unstable lateral malleolar fracture are US$1892 and US$6404, respectively [11].

Mittal et al. recently published that in the short term (one year post operatively), surgery is not superior to non-surgical management for type B1 distal fibula fractures without significant talar shift, which was defined as MCS being at least 2 mm wider than the SCS on a mortise X-ray view of the ankle [5]. To our knowledge, there has been no research yet investigating the long-term outcome of these ankle fractures, thereby comparing surgical treatment with non-operative treatment.

The aim of the current study is to determine the long-term differences in function of the ankle and level of pain in non-operatively and surgically treated patients with an isolated type B fibula fracture. Our hypothesis is that there will be no difference between the operated and non-operatively treated patients in both groups concerning pain and function.

Methods

Study design

This study is a retrospective single-center cohort study performed in the Haaglanden Medical Centre (HMC) in The Hague, a level one trauma center. All consecutive patients aged between 18 and 75 years, treated non-operatively or surgically between January 2008 and December 2015 for an isolated distal fibula fracture at the level of the syndesmosis were included in a database. All trauma radiographs of these patients have been scored. Patients with an isolated type B fibula fracture and MCS ≤ 6 mm were eligible for inclusion. Exclusion criteria were patients with a MCS > 6 mm, a lack of mental capacity, a former fracture of the same ankle, a pre-existent decreased function of the ankle, decreased function of the extremities because of other comorbidities, multi-trauma patients without normal rehabilitation, cognitive impairment, inability to speak Dutch or English. The decision to treat surgically or non-operatively was initially made by the surgeon based on the radiographic diagnostics and his/her judgment of stability of the fracture. Most fractures were evaluated in the outpatient department within one week. Most of the trauma surgeons decided to treat operatively in case of MCS > SCS + 2 mm. Many of our surgeons advised surgery in case of a fibular fracture dislocation >2 mm as well, independent of joint incongruency. Written informed consent was obtained from all patients willing to participate.

Standard practice in our center, in case of non-operative treatment contains a two-week period of non-weightbearing in either a cast or orthesis depending on the surgeons' preference, followed by a weightbearing period dependent on pain complaints. Operatively treated patients were recommended a two-week period of a splint and, in case of good wound healing, weightbearing depending on pain complaints after two weeks.

The database included patient characteristics (age, gender, comorbidities), fracture characteristics (AO-classification, fracture side, additional radiographic diagnostics (MRI or gravity test)) and type of treatment (surgery yes/no, type of surgery, non-operative treatment; duration of immobilization). Moreover, complications and re-surgery for removal of material were recorded. Unfortunately data on percentage of arthrosis was not present.

Fig. 1. Measurements of the mortise radiograph. A: medial clear space, B: superior clear space, C: distal fracture height, D: lateral diastasis.

Radiological parameters

For each isolated distal fibula fracture, the following measurements were achieved from the picture archiving (PACS) based on the mortise view: medial clear space (MCS), the distance between the lateral border of the medial malleolus and the medial border of the talus, at the level of the talar dome; tibio-fibular clear space (TCS) at the level of the epiphyseal scar on the distal part of the tibia; superior clear space (SCS); distal fracture height (distance between the distal tip of the fracture and the talar dome); lateral diastasis (the maximum width of the fracture line). On the lateral view the following measurements were accomplished: posterior diastasis (the maximum width of the fracture line); posterior and anterior fracture height (perpendicular to the level of the talar dome) [12]. Figs. 1 and 2 show these measurements.

Outcome measurements

Outcome was measured using standard questionnaires, which were sent to all eligible patients. After no response, a second questionnaire was sent. A third notification was made by telephone.

The questionnaire consisted of the Olerud-Molander Ankle Score (OMAS), the American Orthopaedic Foot & Ankle Society (AOFAS), the Euroqol-5D (EQ-5D) for quality of life and the Visual Analog Scale (VAS) for pain sensation. The OMAS [13] is a self-administered patient questionnaire with a score of zero (totally im-

Fig. 2. Measurements of the lateral radiograph: A: posterior fracture height, B: posterior diastasis, C: anterior fracture height.

paired) to 100 (completely unimpaired) and is based on nine different items: pain, stiffness, selling, stair climbing, running, jumping, squatting, supports and work or daily activities. The American Orthopaedic Foot & Ankle Society (AOFAS) [14] scale includes questions on pain, activity and functional limitations, walking distance, balance, difficulties with different terrains, influence on daily live and functioning and ranges from 0 (worst score) to 100 (no complaints at all). The EQ-5D [15] is a standardized instrument developed by the EuroQol group as a measure of health-related quality of life and comprises five dimensions: mobility, self-care, usual activities, pain/discomfort and anxiety/depression. Secondary endpoints included any complications and removal of the material. A Visual Analog Scale (VAS) [16] ranging 0–10 was used to measure pain.

Statistical analysis

The statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS), version 24. For all different aspects of the questionnaire, statistics were performed to compare the surgically treated group with the non-operatively treated group, using one-way ANOVA to compare these continuous variables between groups. A p-value <0.05 was taken as level of statistical significance.

The study was approved by the regional medical ethical committee: METC Zuidwest Holland study number 17–054.

Results

In total, 229/751 (31%) patients fulfilled the questionnaire after a mean follow-up of 5.3 years. The patient baseline characteristics of the respondents and the non-respondents are shown in Table 1. The two cohorts (respondents versus non respondents) had similar baseline characteristics. None of the patients treated non-operatively had to have surgery due to secondary fracture displacement.

Table 2 shows the mean scores of all different aspects of the questionnaire, subdivided into non-operative ($n = 130$) and operative ($n = 99$) treated groups. Baseline characteristics did show significant diffrences in age (operative group 56 years vs. non-operative group 61 years, $p = 0.02$) and MCS (operative group 3.6 mm vs. non-operative group 2.9, $p < 0.01$).

For all aspects of the questionnaire, there was no significant difference between non-operative and operative treatment in outcome of function and pain: the EQ-5D score was respectively 0.8 vs. 0.9 ($p = 0.72$), mean VAS pain score 0.8 vs. 1.3 ($p = 0.09$), OMA score 84 vs. 84 ($p = 0.98$) and for the AOFAS 93 vs. 90 ($p = 0.28$). In 33% of the patients who had surgery, the implants were removed due to persistent complaints of pain. In 3% of the surgically treated patients, a wound infection after ORIF required intravenous antibiotic treatment. In the non-operatively treated group, one patient developed a deep venous thrombosis in the fractured leg. (Table 2)

Divided into subgroups, 173 patients (75.5%) had a MCS < 4 mm and 56 patients (24.5%) a MCS 4–6 mm. In the MCS < 4 mm group, 65.3% of the patients were treated non-operatively, in the MCS 4–6 mm group this percentage was 30.4%. In total, 60/99 (60.6%) of the patients that were treated surgically, had a MCS < 4 mm.

The baseline characteristics and results of the subgroup with MCS 4–6 mm are shown in Table 3. The mean EQ-5D score was

Table 1
Baseline characteristics of the responders vs. non-responders.
Medial Clear Space (MCS), Superior Clear Space (SCS).

	Responders ($n = 229$)	Non -responders ($n = 556$)	One-way ANOVA
Mean age (in years)	58.6 (20–95)	47.3 (21–76)	$p = 0.000$
Male (*n*)	93 (40.6%)	309 (50.6%)	$p = 0.114$
Smokers (*n*)	15 (6.6%)	14 (2.6%)	$p = 0.000$
Diabetes (*n*)	13 (5.3%	6 (1.1%)	$p = 0.039$
Treatment			
Non-operative (*n*)	131(53.0%)	324 (58.2%)	$p = 0.373$
Operative (*n*)	116 (47.0%)	232 (41.8%)	$p = 0.373$
Follow up (in years)	5.3 (1.7–9.0)	5.8 (2.9–9.6)	$p = 0.001$
Medial clear space (MCS)	3.3 (1.2–5.8)	3.4 (1.6–5.9)	$p = 0.133$
MCS group (*n*)			
<4 mm	173 (75.5%)	412 (74.1%)	$p = 0.795$
4–6 mm	56 (24.5%)	144 (25.9%)	$p = 0.795$
Superior Clear space (SCS)	3.2 (1.5–4.9)	3.2 (1.8–5.2)	$p = 0.754$
Laterale diastasis	1.5 (0.0–7.4)	1.4 (0.0–5.4)	$p = 0.364$
Posterior diastasis	1.6 (0.0–8.0)	1.7 (0.0–6.4)	$p = 0.438$

Table 2
Radiographic and questionnaire results operative vs. non-operative.
Medial Clear Space (MCS), Superior Clear Space (SCS), Talofibular Clear Space (TCS), Visual Analogue Scale (VAS), Olerud and Molander Ankle Score (OMAS), American Academy of Orthopaedic Surgeons (AAOS), EuroQol 5D (EQ-5D).

	Operative ($n = 99$)	Non-operative ($n = 130$)	One-way ANOVA
Patient characteristics			
Mean age (in years)	56 (25–86)	61 (20–95)	$p = 0.022$
Male (*n*)	34 (34.4%)	59 (45.4%)	$p = 0.093$
Smoking (*n*)	12 (12.1%)	3(2.3%)	$p = 0.000$
Diabetes (*n*)	3 (3.0%)	7 (5.4%)	$p = 0.070$
Radiographic results			
Medial clear space (MCS) (in mm)	3.6 (1.4–5.8; σ 1.0)	2.9 (1.2–5.1; σ 0.8)	$p = 0.000$
MCS < 4 mm (n)	60 (60.6%)	113 (86.9%)	$p = 0.000$
MCS > SCS (superior clear space) + 2 mm	12 (12.1%)	1 (0.8%)	
Talofibular Clear Space (TCS) (in mm)	3.7 (1.7–6.6; σ 1.1)	3.4 (1.0–7.2; σ 1.1)	$p = 0.43$
Laterale diastasis (in mm)	1.9 (0.0–7.4; σ 1.2)	1.2 (0.0–3.2; σ 0.7)	$p = 0.000$
Posterior diastasis (in mm)	1.9 (0.0–7.6; σ 1.4)	1.2 (0.0–8.0; σ 1.1)	$p = 0.000$
Distal fracture height (in mm)	1.2(−5.8–10.3; σ 2.7)	2.4 (−9.5–34.8; σ 5.0)	$p = 0.046$
Posterior fracture height (in mm)	34.8 (1.4–151.0; σ 20.6)	30.3 (7.4–69.2; σ 10.6)	$p = 0.045$
Anterior fracture Height (in mm)	5.9 (−6.0–34.4; σ 5.7)	6.0 (−4.3–30.1; σ 6.8)	$p = 0.901$
Fracture angle (degrees)	144 (1–172; σ 25)	144 (1–162; σ 19)	$p = 0.983$
Outcome			
Visual Analogue Scale (VAS) for pain	1.3 (0.0–8.00; σ 2.1)	0.8 (0.0–8.0; σ 1.7)	$p = 0.091$
Olerud-Molander Ankle Score (OMAS)	84 (25–100; σ 14)	84 (35–100; σ 14)	$p = 0.988$
American Academy of Orthopaedic Surgeons (AAOS)	90 (0–100; σ 17)	93.0 (0–100; σ 15)	$p = 0{,}281$
EuroQol 5D (EQ-5D)	0.9 (0.0–6.0; σ 1.5)	0.8 (0.0–6.0; σ 1.4)	$p = 0.720$
Removal of hardware	33 (34.4%)		
Deep infection:	1 (0.4%)	–	
Superficial infection	1 (0.4%)		
Nerve injury	1 (0.4%)	–	
Deep Venous Trombosis	–	1 (1.2%)	

Table 3
Baseline characteristics and questionnaire of the subgroup MCS 4–6 mm.
Visual Analogue Scale (VAS), Olerud-Molander Ankle Score (OMAS), American Academy of Orthopaedic Surgeons (AAOS), EuroQol 5D (EQ-5D).

	Non-operative ($n = 17$)	Operative ($n = 39$)	One-way ANOVA
Mean age (in years)	60.6 (35–95)	50.2 (25–80)	$p = 0.018$
Follow up (in months)	70.5 (31–106)	55.4 (22–102)	$p = 0.050$
Male	13 (76.5%)	18 (46.2%)	$p = 0.036$
VAS pain	0.5 (0.0–2.0)	1.1 (0.0–7.5)	$p = 0.199$
Olerud-Molander Ankle Score (OMAS)	83.8 (55.0–100.0)	81.6 (35.0–100.0)	$p = 0.610$
AAOS	94.4 (56.0–100.0)	90.1 (58.0–100.0)	$p = -0.299$
EuroQol 5D (EQ-5D)	1.1 (0.0–4.0)	1.1 (0.0–4.0)	$p = 0.963$

Table 4
Baseline characteristics and questionnaire of the subgroup fibula dislocation > 2 mm.
Visual Analogue Scale (VAS), Olerud-Molander Ankle Score (OMAS), American Academy of Orthopaedic Surgeons (AAOS), EuroQol 5D (EQ-5D).

	Non-operative ($n = 25$)	Operative ($n = 68$)	One-way ANOVA
Mean age (in years)	64.4 (24–95)	56.2 (25–86)	$p = 0.043$
Follow up (in months)	59.7 (20–106)	29.1 (0–106)	$p = 0.428$
Male	14 (56%)	33 (48.5%)	$p = 0.528$
VAS pain	0.60 (0.0–6.0)	1.5 (0.0–8.0)	$p = 0.080$
Olerud-Molander Ankle Score (OMAS)	82.8 (35–100)	85.5 (35–100)	$p = 0.443$
AAOS	96.4 (52–100)	91.00 (0–100)	$p = 0.116$
EuroQol 5D (EQ-5D)	0.33 (0–3)	0.69 (0–6)	$p = 0.242$

in the non-operatively treated cohort 1.06 vs. 1.08 in the surgically treated cohort. ($p = 0.96$) The mean VAS pain score in this group was respectively 0.50 vs. 1.11 ($p = 0.19$), the OMA score was 83.82 vs. 81.62 ($p = 0.61$) and for the AOFAS score the MCS 4–6 mm cohort scored respectively 92.83 vs. 91.57 ($p = 0.42$) (Table 3)

Table 4 shows results of the subgroup with fibula dislocation >2 mm. The mean fibula dislocation (being maximum dislocation on lateral or anterior-posterior radiograph) ranged from 0.0–8.0 mm in the non-operatively treated group and from 0.0 to 7.6 mm in the surgically treated group. Of the subgroup with fibula dislocation >2 mm, 25/93 (26.9%) was treated non-operatively vs. 68/93 (73.1%) surgically. Also within this group, results for VAS (0.6 vs. 1.5, $p = 0.08$), OMAS (82.8 vs. 85.5, $p = 0.08$), AAOS (96.4 vs. 91.0, $p = 0.11$) and EQ-5D (0.33 vs. 0.69, $p = 0.24$) were not significantly different comparing non-operative and surgical treatment.

Discussion

One of the most common ankle fractures is the B type, with its fibula fracture at the level of the distal tibio-fibular syndesmosis. This type of injury can be stable (without medial injury) or unstable (with an additional medial fracture or deltoid ligament rupture). Stable fractures can be safely treated nonoperatively. Even despite fibular displacement up to 5 mm, this is the treatment of choice leading to excellent function [17-21]. On the contrary, for unstable fractures surgical treatment is advised in healthy patients.

The mortise radiograph is the most commonly used diagnostic tool to differentiate between stable and unstable fractures. However, when using only this radiograph, no information is given about medial ligament injury. In current research, several other radiographic diagnostic tools are being investigated to determine the most sensitive predictive tool in diagnosing medial injury. For example, a recent study showed that the gravity stress test has a sensitivity of 100% and a specificity of 91.7% compared to the reference standard MRI in predicting deep deltoid ligament injury [22].

Other studies found good results with 100% specificity and sensitivity for detecting deltoid rupture with ultrasound [23,24]. However, the numbers in these studies were very small and radiologists with sufficient expertise to perform such ultrasounds are not always present in-hospital. Also, the manual ankle stress radiograph [25] (sensitivity and specificity of respectively 66% and 77% compared to MRI) and weight-bearing radiograph [26-28] were investigated recently. The latter, however, was not compared to MRI or surgical exploration as reference standard.

These different diagnostic tools may be useful to predict medial injury and therefore support the decision-making process in choosing non-operative or surgical treatment based on biomechanical principles. However, it is noticeable that studies comparing the clinical outcome of both treatment regimens are lacking.

The recently published CROSSBAT study showed that in the short-term (12 months post-injury), surgery is not superior to non-operative treatment in isolated distal fibula fractures (type 44-B1 fracture without MCS > 2 mm wider than superior clear space on the mortise view) in terms of ankle function and health-related quality of life. Respectively, the results for the surgically vs. non-operatively treated group in two main questionnaires: the American Academy of Orthopaedic Surgeons Foot and Ankle Outcomes Questionnaire (FAOQ) and the physical component score (PCS) of the SF-12c2 General Health survey, showed results of 43.8 vs. 44.7 ($p = 0.65$) and 47.1 vs. 46.8 ($p = 0.9$) [5].

To our knowledge, the current study is the first to investigate the long-term outcome of these specific type of ankle fractures by comparing the two types of treatment.

This study reveals that in adult patients, aged 18 to 75 years with an isolated type B ankle fracture, surgical management was not superior to non-surgical management in terms of pain, ankle function and health-related quality of life after a mean follow-up of 5.3 years. Furthermore, surgery was associated with complications like wound infections and need for re-surgery to remove the material.

It is known that in case of doubt, many surgeons tend to have a preference for surgical treatment mostly based on the MCS widening, thereby often using a cut-off value of MCS > 4 mm [8]. In our study cohort, 70% of the patients presenting with an isolated type B fibula fracture and a MCS between 4–6 mm have been operated. However, recent studies showed that using this threshold, many ankle fractures will incorrectly be diagnosed as unstable and have therefore might be fixed unnecessarily [9,29].

The current study proves that the effectiveness of surgery in stable ankle fractures is not superior to non-operative treatment when comparing long-term outcome. Also, high costs and many risks can be prevented when stable fractures are being treated safely non-operatively. Comparing surgery with non-operative treatment, neither MCS groups (MCS < 4 mm and MCS 4–6 mm) had any significant difference in outcome. Moreover, even with fibula dislocation ranging up to 5.4 mm, this study revealed good results after non-operative treatment. In the Netherlands, for example, many surgeons treat fractures with fibula dislocation >2 mm surgically, even without medial widening [8]. According to the current results, this might lead to surgical overtreatment.

A limitation of this study is the lack of a strict treatment protocol that can be used by the trauma surgeon, leading to confounding by allocation. The decision to treat surgically was based on their own judgment of instability and fibular fracture dislocation. Solely based on the MCS, stability of a type b ankle fracture is not possible as rotation and shortening of the fibula cannot exactly be assessed on the X-ray. Thus, patients with stable fractures may have been treated operatively, as well as patients with unstable fractures treated non-operatively.

Moreover, we are aware that this is a retrospective design and a prospective study is needed to confirm our findings. In our center, we are currently performing a prospective trial that compares the weight-bearing and gravity stress radiographs with MRI scan to indicate complete medial ligamentous injury and therefore instability. Results of this study will hopefully confirm the findings of the current retrospective study.

By using a questionnaire, it is inevitable to have some selection bias. Moreover, we faced a very selective response of 33%, the main drawback of this study; even after second and third notifications mails and calls. As shown in Table 1, this responsive cohort is, however, representative for the total study population. However, although these patients characteristics are representative, they may not be representative for outcome.

Strength of this study is the patient reported outcome. The objective data, derived from the database and the radiographs, combined with the patient's own appraisal of outcome is the most optimal outcome measurement. With a mean follow-up of 5.3 years we were able to compare the outcome of treatments not only during the recent rehabilitation process but also years after.

As a consequence of this current study we changed our protocol and started to perform gravity and weight-bearing radiographs on a regular basis. Making use of Holmes' flowchart [7], we regularly perform a gravity stress radiograph at the Emergency Department in case of type B fibula fractures without a medial fracture and decide for surgical treatment in case of a MCS > 6 mm. When the MCS is <6 mm, a plaster of paris is applied. Within a week after injury a weight bearing radiograph is performed and if no widening of the MCS is shown on this radiograph, we definitively decide to treat non-operatively. In doing so, the number of patients that is selected for operative treatment could be significantly lowered with good clinical outcome. We hope that other surgeons do realize that when in doubt about the stability of an isolated type B ankle fracture, further diagnostics should be performed. Without proven instability, these injuries can be treated safely non-operatively; without risks and costs of surgery, and with good long-term outcome in terms of pain and function.

Declaration of Competing Interest

All authors declare that they do not have any conflict of interests.

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