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REVIEW

A Current Review of Foot Disorder and Plantar Pressure Alternation in the Elderly

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Fall is a very common injury, especially in older adults with foot deformities and other foot disorders. Even a small fall may cause fatal damage to this cohort. The purpose of this study was to conduct a review elucidating plantar pressure pattern under different foot deformities in the elderly. English-language search of the electronic databases in PubMed, ScienceDirect, Google Scholar, and Web of Science was conducted from 2000 to May 2020. Fifteen studies were found after literature searching and screening. Among them, 2 studies described the plantar pressure of plantar hyperkeratosis lesions in the elderly, 2 studies depicted the plantar pressure of pronated foot supinated foot in the elderly, 4 studies explored the plantar pressure distribution of hallux valgus and other foot deformities, and 7 studies focused on the plantar pressure of diabetic foot deformity in the elderly. Foot deformity appears to alter the plantar pressure in the elderly, and plantar pressure characteristics differ according to foot deformities.

Keywords: Foot pathology; Foot shape; Gait; Plantar Loading; Older adults

Introduction

Fall is the popular cause of injuries among the senior adults, which is correlated to hospitalizations, and even about death and it becomes a major public health concern (Awale et al. 2017; Dellinger et al. 2006). The quantity and severity of injuries seems to increase by aging. Approximately 40% of the seniors aged more than 65 years living at home will experience fall at least once per year, about 1 in 40 of the group will be hospitalized. The risk of mortality 12-month after being hospitalized for a fall is about 50% (Rubenstein 2006). Among those older people living in institutions, there even have higher rate of falls (Luukinen et al. 1994). Declines in sensory and motor function and integration have been identified as the major inherent factors contributing to the fall (Nitz et al. 2004).

While the causes of falls are multifactorial, there is one common feature: falling mainly occurs during walking. Gait capacity of seniors has been related to the increased survival rates, fall prevention, and the quality of lifespan. During regular gait, the foot is usually the only part of the body directly attached to the ground. Hence, any condition that can disturb the normal function of the foot during ambulation is likely to damage the stability of gait and increase the risk of falls (Mickle et al. 2010).

The human foot needs to bear loads during bipedal locomotion through the whole life (Bosch et al. 2009). Foot dysfunction can restrict normal progression of walking and could be a contributing reason for falling and functional disability in older adults (Menz et al. 1999). Helfand et al. (Helfand et al. 1998) assessed clinically determined foot problems and subjective foot complaints of 417 seniors living in residential care facilities. The study suggested that hallux valgus, prominent metatarsal heads and abnormal medial arch structure were the most common orthopedic deformities while the most conventional subjective foot complaint was pain, subsequently by swelling, corns, calluses, and bunions. In another study (Helfand 2004), 1000 ambulatory and not institutionalized individuals over 65 years of age received a standardized and validated podiatric examination assessment protocol or index, results showed that 74.6% of the patients had a history of foot pain, 57.2% were under current care for diabetes while 22.9% under the care for peripheral vascular disease, and 94.2% had onychodystrophy. 64.2% of them had one or more deformities of foot, 64.0% showed part loss of protective sensation, and 81.7% had one or more sign s or symptoms

of peripheral arterial deficiency. Foot deformities and other conditions were in a high percentage of senior older than 65 years. Foot related issues closely associated with daily activities of seniors.

During walking, plantar pressure is generated while the body weight is shifted to the stance limb (Gu et al. 2011; Chen et al. 2019; Fang 2018). Measurement of plantar pressure distribution is clinically helpful because it can contribute to detect anatomical foot deformities, leading to strategies for preventing abnormal foot pressure (Hessert et al. 2005). Plantar pressures are of important concern owing to the risk of foot deformities, and as a source of pain (Mei et al. 2019). In patients with confirmed peripheral neuropathy or deformity, altered plantar pressure pattern is a common finding (Tong et al. 2011; Bus et al. 2005). Scott et al. (Scott et al. 2007a) concluded that older people presented flatter/more pronated feet, decreased range of motion of the 1st metatarsophalangeal and ankle joints, as well as a higher commonness of hallux valgus, toe deformities which contribute to altered plantar pressure during gait. Mickle et al. (Mickle et al. 2011) assessed 312 community-dwelling older people's presence of hallux valgus and lesser toe deformities and found that older people with hallux valgus and lesser toe deformities showed different forefoot plantar pressure patterns. Bacarin et al. (Bacarin et al. 2009) found from the clinical history of diabetic patients that the distribution of plantar pressure changed, which leads to an increased load of the rearfoot and midfoot, as well as an increase in the variability of foot pressure during barefoot gait. The information of plantar pressure provides further insights on the dynamic function of the foot, which may be useful in the development of interventions for pressure-related problems in older people.

The objective of this review was to summarize the current studies regarding the plantar pressure of older people with foot deformities. This review shall shed light on knowledge of the plantar pressure pattern of the elderly with foot deformities, for researchers and clinicians. The knowledge may be useful to apply and analyze the plantar pressure of foot, so that to decide an appropriate treatment strategy for the old adults.

Methods

Eligibility criteria and study selection

Search strategy

Literature search strategy was mainly based on four electronic databases, PubMed, ScienceDirect, Google Scholar and Web of Science. English-language searches using the following keywords: 'the aged' OR 'old people' OR 'the elderly', 'foot deformity' OR 'foot disease' OR 'foot disorders', 'plantar pressure' OR 'plantar loading' OR 'gait'. The search literature was limited to publication dates from 2000 to May 2020. The snow balling method was also used to review the reference list of all eligible studies in order to identify other potentially eligible studies.

Inclusion criteria

In the process of searching literature, studies were mainly selected from four aspects: the selection of subjects, the method of experimental design, the purpose of the research and the analysis of the results. All four aspects of the selected paper must meet the following inclusion criteria: 1) All subjects in the experimental group must over 60 years old or older, and the control group must match the gender and age of the experimental group. 2) Only experimental studies with clear data were included in this review. 3) The studies ought to aim at investigating the foot pressure among the elderly with foot deformities, or diseases which resulted abnormal foot pressure. 4) The results should illustrate the characteristic of foot pressure among the old with foot deformities and other diseases. All the included articles were published in peer-reviewed journals with full-text available.

Exclusion criteria

The articles were excluded if they were not meet the following criteria: 1) The age of the experimental group was less than 60 years old, or the age and gender of the control subjects were not matched with that of the experimental group. 2) No plantar pressure-related data was selected or experimental data was incomplete. 3) The selected article was not in English or full-text was not available.

Data extraction

The search flowchart was shown in **Figure 1**. 492 related articles were found in four electronic databases and 221 of the duplicate articles were removed. 6 papers were removed because the full-text can't be found, and 206 studies were excluded via checking the title and abstract. In 59 remain studies, 46 articles were excluded: 8 conference papers, 22 studies had no relationship between foot deformity in the elderly,

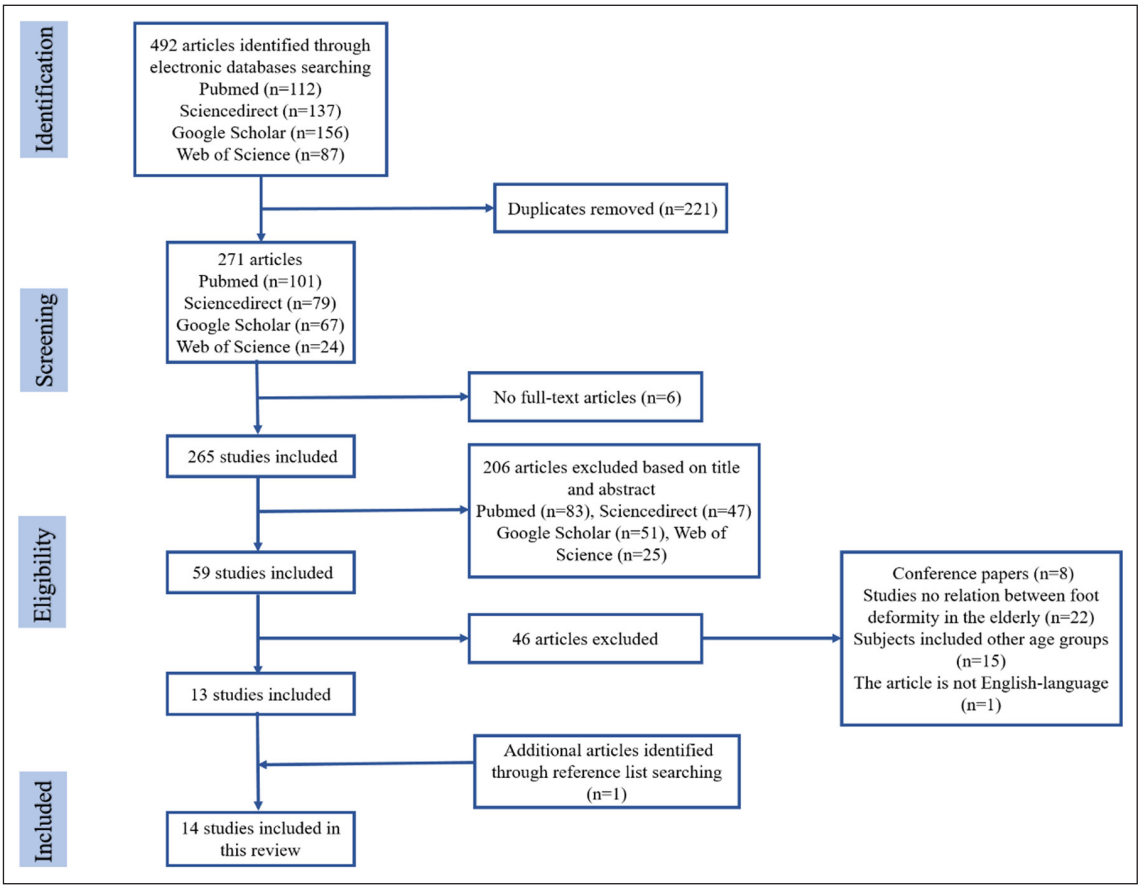

Figure 1: The flowchart of literature searching and screening.

15 articles included other age groups, one article was not written in English. One paper was found through the searching of the reference list. Thus, 14 articles were included in this review.

Results

Table 1 summarized the study characteristics for all full-text articles included in the review. Of the 14 included studies, 1 studies described the plantar pressure of plantar hyperkeratosis lesions in the elderly, 2 studies depicted the plantar pressure of pronated foot and supinated foot in the elderly. 7 studies studied the plantar pressure pattern of diabetic foot deformity in the elderly, 4 studies explored the plantar pressure of hallux valgus and other foot deformities.

Plantar hyperkeratotic lesions

Menz et al. (Menz et al. 2007) compared the callus and non-callus areas of the feet of 292 subjects with plantar hyperkeratotic lesions, and found that the pressure on the callus of the plantar soles was significantly higher in the elderly.

Pronated foot and supinated foot

Mohd Said et al. (Mohd Said et al. 2016) by comparing the pressure distribution of the soles of the pronated foot and the supinated foot in the elderly found that the peak pressure of the pronated foot was significantly lower than that of the supinated foot. Tuna et al. (Tuna et al. 2014) through the intervention of orthotics in the elderly with pronated foot, the results showed that the static balance of patients with pronated foot was unstable, and the use of orthotics has no effect on the balance parameters.

Diabetic foot deformity

Diabetic foot accompanied by ulcers often occurred in the big toe and the bottom of the toe, and the average peak plantar pressure time score of patients with plantar ulcer was significantly higher than that of normal people (Tong et al. 2011; Yu et al. 2011; Fernando et al. 2016). Ko et al. (Ko et al. 2012) found that the walking speed of diabetic patients was significantly lower than that of the control group, resulting in a

Table 1: The summerization of study characteristics.

Study	Foot deformity type	Study population	Study design	Plantar pressure	Conclusion
Menz et al. (2007)	Plantar hyperkeratotic lesions	292 subjects (99 men and 193 women) aged 62–96 years (mean aged 77.6 ± 6.9)	comparisons were made between calluses and non-callused areas of the foot.	Those with calluses at the second, third through fifth metatarsophalangeal joints and the big toe had significantly higher pressure spikes on the soles of the feet than those without calluses.	Plantar pressures are significantly greater under callused areas of the foot in elderly.
Hagedorn et al. (2013)	Hallux Valgus Hammer Toes Morton's Neuroma Overlapping Toes Tailor's Bunion Plantar Fasciitis Hallux Rigidus Claw Toes	Data were from the Framingham foot study, mean age 66.2 ± 10.5 years	The subgroups of foot posture and function were established by using the improved arch index and the pressure deviation center index of the plantar pressure scan.	In the elderly, hallux valgus patients had a significantly increased incidence of bunions and overlapping toes, while hallux valgus patients had a significantly reduced incidence of bunions and stiffness.	Foot function are connected with the presence of certain foot diseases.
Menz et al. (2005)	Hallux valgus Lesser toe deformities Corns on toes Plantar calluses	172 older people (53 men, 119 women) aged 62–96 years (mean age 80.0 ± 6.4 years)	Subjects completed tests of foot posture, range of motion, strength, sensation and toe deformity using a floor-mounted resistive sensor mat system.	Maximum force and stress in most areas of the foot is explained by differences in body weight.	The structural foot and ankle joint characteristics determined from clinical measurements can explain some key aspects of the plantar load pattern of the foot.
Menz et al. (2005)	Hallux valgus	71 people (24 men, 47 women) between 75 and 93 (mean 80 ± 4) years of age	Temporal spatial parameters of the gait and acceleration patterns of the head and pelvis of 71 individuals walking on a flat surface and a specially designed irregular sidewalk.	Subjects with more severe hallux valgus showed a decrease in walking speed and step length, which was more pronounced on irregular surfaces.	Valgus has significant adverse effects on gait patterns in older adults and may lead to instability and risk of falls, especially when walking on irregular terrain.
Mickle et al. (2011)	Hallux valgus and lesser toe deformities	A total of 312 men and women over the age of 60 were randomly selected as study participants.	The spatiotemporal parameters, postural sway and dynamic plantar pressure distribution of the subjects were measured.	In older patients with bunion (n = 36) and with little toe deformity (n = 71), plantar anterior pressure patterns changed.	Toe deformity changes the pressure distribution on the soles of the feet when walking.
Mohd Said et al. (2016)	Pronated foot supinated foot	50 older persons (mean 69.98 ± 5.84) form community-dwelling	Foot pressure (max P) and contact area were analyzed by using Footscan@ Rsscan platform.	The peak of plantar pressure in the forefoot area of all foot types was significantly different, and the peak of plantar pressure in the pronated foot was significantly lower than that in the supinated foot.	The type of foot affected the maximum pressure on the soles of the elderly and the functional reach distance showed some association.

(Contd.)

Study	Foot deformity type	Study population	Study design	Plantar pressure	Conclusion
Tuna et al. (2014)	Pronated foot	10 healthy elderly with valgus (age 67.1 ± 5.5 years) and 16 healthy elderly with normal valgus (age 67.1 ± 5.9 years).	Kistler force plate was used to measure the static balance of two limbs standing in four shoe wearing situations.	There was no significant difference in the orthodontic effect between the four types of orthodontic devices.	The balance of pronated foot types tends to be unstable, but this is not significant. The use of orthotics had no effect on balance parameters, including eliminating the effects of eye closure.
Tong et al. (2011)	Type 2 Diabetes Mellitus	35 patients (mean 64.6 ± 10.5) with type 2 diabetes and 38 patients (mean 48.9 ± 5.3) without tactile or foot deformity.	The plantar pressure of the subjects was measured.	The mean pressure-time integrals of the right foot of diabetic patients was significantly higher than that of normal people.	Changes in plantar pressure in diabetic patients may occur prior to the establishment of peripheral motor and sensory neuropathy.
Fernando et al. (2016)	Type 2 Diabetes Mellitus	21 cases with diabetic foot ulcers aged between 52 and 72 years (mean 66), 69 diabetes controls aged between 58 and 72 years (mean 63) and 56 healthy controls aged between 55 and 73 years (mean 56)	A pre-established method was used to measure plantar pressure at 10 sites and the duration of the standing phase.	Most ulcers are on the big toe and the sole of the toe. The mean peak plantar pressure and toe pressure-time score, as well as the midfoot score, were significantly increased in patients with foot ulcers.	In the case of higher plantar pressure, patients with diabetic foot ulcers are expected to reduce plantar pressure despite having a longer standing period.
Bus et al. (2004)	Diabetic	20 diabetic patients (13 men, 7 women) aged mean 64.4 ± 11.2 with neuropathy and foot deformity	Peak local in-shoe pressure and force-time integrals were measured when the subjects walked in flat shoes or custom insoles.	Custom-made insoles showed smaller peak pressures and force-time integrals in the heel and first metatarsal head regions.	Custom-made insoles were more effective than flat insoles in off-loading the first metatarsal head region, but with considerable variability between individuals.
YU et al. (2011)	Diabetic Toe Deformity	30 patients (15 males and 15 females) mean aged 56.2 ± 8.3 years with diabetic claw or hammer toe deformity and 30 healthy patients (15 males and 15 females) with an age of 57.9 ± 7.1 years	Foot pressure was measured in different areas of the foot using the f-scan® dynamic foot pressure analysis system.	The peak pressure of the big toe and the first to fifth metatarsal bone in the patient group was significantly higher than that in the control group, and the peak pressure of the posterior foot in the patient group was significantly lower than that in the control group.	Diabetics with malformed toes have abnormally high levels of plantar pressure.
Tuna et al. (2014)	Type 2 Diabetes Mellitus	43(27 women, 16 men; age: 63.5 ± 9.2 years old) diabetic foot disease course more than 10 years old; 41 patients (female: 23 males: 18; age 54.3 ± 11.5 years old) of disease was less than 10 years	Each subject was assessed in a static and dynamic pedographic manner.	Dynamic plantar pressure evaluation: in the first group, the peak pressure of phalangeal bone was significantly increased in the left foot, while the contact area of the right foot was lower.	In patients with type 2 diabetes over a 10-year course, the contact area during forefoot walking decreased and the peak pressure increased.

(Contd.)

Study	Foot deformity type	Study population	Study design	Plantar pressure	Conclusion
Ko et al. (2012)	Diabetes	9 subjects (7 female, 2 male; age 68.7 ± 7.5) with diabetes and 9 (7 female, 2 male; age 72.3 ± 10.9) age gender matched group without diabetes	A steady walking speed, peak plantar pressure and the fore and rear foot (F/R) peak plantar pressure ratio and gait variables were measured during barefoot walking.	The walking speed of diabetic patients was significantly lower than that of the age and gender matched group, leading to a significant reduction in the peak plantar pressure of the front and rear feet during barefoot walking.	The diabetic group was significantly lower than the control group in the aspects of step frequency, step length, gait, step length, step frequency and toe in/out Angle.
Tang et al. (2014)	Type 1 and type 2 Diabetes Mellitus	114 patients with type 1 (N = 31) or type 2 (N = 83) diabetes (62 men and 52 women; mean age, 57.7 ± 15.4 years; duration of diabetes, 12.3 ± 11.2 years; neuropathy, 38%)	the in-shoe plantar pressures were measured through using F-Scan@ at seven ROI (hallux, metatarsal head 1, 2, 4, 5, the foot side, heel) on five occasions.	Compared with prefabricated insoles, the peak pressure in the heel area of EVA insoles is significantly lower. There are also some differences in the other six ROI indicators.	In patients with diabetic foot ulcers, the insole maintains its pressure redistribution characteristics over a long period of time when the insole is used.

significant reduction in the peak pressure on the soles of the front and rear feet during barefoot walking. When assessing dynamic plantar pressure in 43 elderly patients with type 2 diabetes for more than 10 years, Tuna et al. (Tuna et al. 2014) found that they had less plantar contact areas and increased peak pressure during walking. In the elderly diabetic foot patients with customized insole intervention found that the heel and the first phalangeal region showed less peak pressure when walking with the insole (Bus et al. 2004; Tang et al. 2014).

Hallux valgus and other foot deformities

In the elderly, the incidence of bunion and toe overlap was significantly increased in valgus patients, while the incidence of bunion and stiffness was significantly reduced in valgus patients (Hagedorn et al. 2013). The distribution of pressure on the soles of the feet changed during walking in older adults with hallux valgus, and the maximum force and pressure in most areas of the foot could be explained by differences in body weight. Those with more severe bunions experienced a decrease in walking speed and step length, which could lead to falls in older adults and a greater risk of walking on irregular surfaces (Menz and Lord 2005; Menz and Morris 2006; Mickle et al. 2011).

Discussion

The aim of this review was to provide an overview of literature describing the relationship between foot deformities and plantar pressure in the elderly. Fifteen studies fulfilled the selection criteria. The findings of this systematic review indicated that the plantar pressure parameters were closely related to foot deformities in seniors.

Diabetic foot

Diabetic foot problems are a common foot pathology, thus causing significant economic consequences for patients, their families and society. Diabetic foot ulcers are common and disabling, and often result in amputation of the leg (Jeffcoate et al. 2003). The percentage of diabetes is greater in senior adults, and the tendency of diabetes increases with ageing (Helfand 2003). There were some evidences showed that high plantar pressure is an essential risk factor for the development of diabetic foot ulcers (Frykberg et al. 1998; Tong et al. 2011; Merolli et al. 2005). An uneven distribution of plantar pressure is able to easily bring about plantar ulceration and cause the foot deformities like claw and hammer toe which are the common deformities in diabetes patients (Yu et al. 2011). Tong et al. (Tong et al. 2011) compared the plantar pressure of 35 old patients with type 2 diabetes mellitus and 38 nondiabetic subjects in the control group, and concluded that old patients with diabetes mellitus demonstrated higher pressure-time integrals. The relation between type 2 diabetes mellitus duration and plantar pressure also has been studied, Tuna et al. (Tuna et al. 2014) showed that patients with type 2 diabetes, after 10 years of duration, the peak pressure increased and contact area decreased in forefoot during walking.

The knowledge of plantar pressure on old diabetic patients may have positive effect on the treatments. Bus et al. (Bus et al. 2004) investigated the effects of plantar pressures and load redistribution changes with custom-made insoles on 20 old adults with neuropathic diabetic patients with foot deformity, found that custom-made insoles were effective in off-loading plantar pressure of the first metatarsal head region. There was a significant importance of off-loading feet pressure during the ulceration, as well as before ulceration. Whether plantar pressure alterations can predict ulcer therapeutic should be the emphasis of future research.

Toe deformities

Hallux valgus and lesser toe deformities are both highly prevalent foot deformities in the elderly. These foot problems can have functional effects, as the hallux valgus and lesser toe deformities has been related with worse performance in balance and functional tests (Menz, Morris, et al. 2005), and older people who once fall show more severe hallux valgus than those non-fallers (Menz, Morris, et al. 2006).

Hallux valgus

Hallux valgus is a common deformity, causing lateral deviation of the hallux and medial displacement of the first metatarsal, and the first metatarsal head bony enlargement (Mann et al. 1981; Menz et al. 2011; Menz and Lord 2005; Xiang et al. 2018). Some evidences have suggested that hallux valgus is an independent risk cause for falls (Kosk et al. 1996; Tinetti et al. 1988). As the deformity develops, the lateral deviation of the hallux interferes with the regular alignment and function of the lesser toes, leading to hammer toe or claw

toe deformities, altered plantar pressure patterns (Menz et al. 2011). Several researchers have demonstrated changed plantar pressure patterns in hallux valgus subjects compared to asymptomatic individuals (Kernozek et al. 2003; Nyska et al. 1998). There are only a few studies studied the plantar pressure of older adults with hallux valgus. Mickle et al. (Mickle et al. 2011) found that the elderly with moderate-to-severe hallux valgus presented a significantly greater peak pressure and pressure–time integral under the first and second metatarsals, comparing to those older people without hallux valgus. Menz et al. (Menz and Morris 2006) concluded that maximum force under the hallux was linked to the severity of hallux valgus in senior adults and age did not explain further alteration in the peak plantar pressure variables except of peak plantar pressure under the hallux.

Lesser toe deformities

Typical lesser toe deformities include mallet toe, curly toe, crossover toe, hammer toe and claw toe. Lesser toe deformities are usually caused by changes in normal anatomy that produces an imbalance between the extrinsic and intrinsic muscles (Shirzad et al. 2011). Bus et al. (Bus et al. 2005) reported that diabetics with hammer or claw toe deformities caused significantly higher peak plantar pressures and pressure–time integrals at the central metatarsals than the matched diabetic patients without lesser toe deformities and concluded that distal deviation of the metatarsal fat pad was the main mechanism behind the correlation between the increased metatarsal pressure and toe deformities. Mickle et al. (Mickle et al. 2011) found that older participants with lesser toe deformities showed a significantly higher peak plantar pressure and pressure–time integral under the second and third metatarsals, while generated a significantly higher peak plantar pressure and pressure–time integral under lesser toes compared with controls. Under the case of lesser toe deformities, older adults are unable to task in their normal weight-bearing capacity because of the reduced contact area of the lesser toes, leading to higher peak plantar pressures under the toes and overload weight borne throughout the metatarsals, which may be a cause of a fall.

Older adults with hallux valgus and lesser toe deformities exhibit altered foot loading patterns over the forefoot and lesser toes. These findings deliver further insights into the correlations between the foot structure and function, which could be a contribution in the development of intervention strategies or rehabilitation methods for pressure-related foot complaints in the elderly with toe deformities.

Plantar hyperkeratotic lesions

Hyperkeratotic lesions (calluses and corns) is defined as thickening of the cuticle of the epidermis produced by hyperplasia or hypertrophy of its own cells (Rubin 1949). Plantar hyperkeratotic lesions are very widespread among the older population, affecting 30–65% of seniors aged over 65 years (Dunn et al. 2004; Araguas García et al. 2017). Araguas García et al. (Araguas García et al. 2017) analyzed the location of plantar hyperkeratotic lesions. In a total number of 850 older participants, 529 (62%) presented with plantar hyperkeratotic lesions. In total, 87 hyperkeratotic patterns were recorded, the most common patterns were the first metatarsophalangeal joint (MPJ) medial side (8.7%), the medial side of the first MPJ along with the medial side of the first interphalangeal joint (IPJ) (8.5%) and the first IPJ medial side (7.7%). A large study carried on by Menz et al. (Menz et al. 2007) conducted on older people contained 292 participants, confirmed significant increases in plantar peak pressure under the callused regions of the foot during gait, with the exception of the lesser toes and the first metatarsophalangeal joint.

Early recognition and treatment of calluses on plantar may prevent skin rupture, as plantar calluses often occur foot ulceration. Given that hyperkeratotic lesions appear to form under regions of increased plantar pressure, diverse offloading techniques may play an important role in the prevention as well as treatment of these lesions by plantar pressure relief or redistribution in order to reduce the underlying high pressure. Thus, increasing the gait balance and decreasing the risk of falls in old population.

Supinated and pronated foot

Aging may lead to alterations in the biomechanical structure of the human foot. The foot posture can be classified into three types which are the normal, supinated and pronated foot. A neutral foot posture has a mechanical advantage to alter the ground surface while promoting shock absorption and tacts as a rigid fulcrum that pushes the body in space during walking (Tiberio 1988). However, both pronated and supinated foot can badly affect gait mechanics. Individuals with abnormal foot posture type may have different plantar pressure distribution compared with the normal foot during pressure analysis.

Mohd Said et al. (Mohd Said et al. 2016) examined how foot type influences the plantar pressure distribution of older people and turned out that pronated foot showed a significant decrease of max pressure in the

forefoot region compared to the supinated foot, specifically in the fourth and fifth metatarsals. Meanwhile, all three-foot types showed no significant differences in contact areas. Scott et al. (Scott et al. 2007b) compared foot features and plantar pressure patterns in young and older patients and found that the more pronated of the foot, the less lateral plantar loading. Theoretically, older people may present a pronated foot when compared to the younger people because of significant alterations in the musculoskeletal and sensory characteristics of the foot all the way through aging processes (Scott et al. 2007b). Therefore, the peak plantar pressure would increase during walking to compensate for the changed musculature of the foot (Bosch et al. 2009).

There are still not enough samples of the plantar pressure on deformity foot types (supinated and pronated foot) in older adults. We believe that more studies are required to evaluate the variations of plantar pressure during walking or static posture in older population with abnormal foot types.

Conclusion

This is the first review that concluding the effect of foot deformity on the plantar pressure in the older cohort. Despite limited evidence, foot deformity appears to alter the plantar pressure in the elderly, and plantar pressure characteristics differ according to foot deformities. Old patients with diabetes mellitus demonstrated higher pressure-time integrals. Older people with moderate-to-severe hallux valgus presented a significantly greater peak pressure and pressure-time integral under the first and second metatarsals, while those with lesser toe deformities exhibited a significantly higher peak plantar pressure and pressure-time integral under the second and third metatarsals and lesser toes compared with controls. Hyperkeratotic lesions showed an increase in plantar peak pressure under the callused regions of the foot during gait in seniors. These findings provide further insights of the relationships between plantar pressure and foot deformity in the elderly, and may contribute to the development of intervention and rehabilitation strategies for pressure-related foot complaints in the elderly.

Competing Interests

The authors have no competing interests to declare.

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