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Short Communication

Aviation Podiatry - What place does podiatry have in aerospace medicine?

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ABSTRACT

Introduction: With there being 12 commercial airlines within the U.K and over 4 billion passengers travelling by aircraft every year, it is of no surprise that thousands of men and women are employed as cabin crew. Physical demands imposed upon cabin crew have long been recognized and known to place this particular population at an increased risk of experiencing a work-related injury. Whilst previous research would also suggest that there is a relationship between footwear and the occurrence of musculoskeletal (MSK) lower limb symptoms, there is a need to consider such a relationship specifically among an aviation cabin crew population.

Methods: Quantitative data was obtained from a sample of 250 junior crew at a leading airline in the Middle East over 12 months. The sample involved both female and male crew of a healthy BMI who were aged between 22-30 years. All participants were asked closed questions with regard to their lower limb health and footwear. Dynamic gait scans utilizing a Podotech scanner were also used to assess the participant's gait and validate other data.

Results: The screening found that 34% of the crew were found to have an MSK podiatric issue with 30% requiring orthoses. Of the 34%, 30% of this group had footwear issues. Common biomechanical issues were identified in the sample group. A holistic approach to care that included the provision of aviation podiatry allowed longer-term treatment outcomes to be achieved. The use of orthotics that were made from EVA and in accordance with recent podiatric research proved beneficial in helping to address underlying biomechanical issues.

Conclusion: The findings presented a more detailed analysis of lower limb biomechanical issues among cabin crew and how such issues could have wider implications for the occupational role of the sample group. Consideration to podiatric issues among aviation staff, as a whole, should not be overlooked. Given the incidence of lower limb issues among the sample group, future rehabilitation and prevention strategies would clearly benefit from the specialist insights of an aviation podiatrist contributing as part of a multi-disciplinary aeromedical team.

Keywords: Aviation Podiatry, Aeromedical, Cabin Crew, Biomechanics, Footwear, Musculoskeletal, Occupational Injury

Introduction

The role of cabin crew is diverse and has the potential to impose excess strain on an individual's musculoskeletal (MSK) system.[1,2,3] With there being 12 commercial airlines within the U.K and over 4 billion passengers travelling by aircraft every year, it is of no surprise that thousands of men and women are employed as cabin crew.[4,5] Duties typically include arming/disarming doors, performing security checks, lifting heavy baggage, maneuvering heavy meal and beverage carts (weighing up to 90 kg and 113 kg respectively when full in economy class)

and dealing with medical or security emergencies.[1,2,3,6,7]

Sleep deprivation, navigating international time zones, operating at a heightened altitude, and wearing a uniform that could arguably be considered a hindrance to performing tasks, creates further complexities that should be factored in when considering the incidence of industrial injuries affecting the lower limbs.[8,9,10] The incidence of turbulence is also recognized as further increasing the risk of injury. Research by Tyaryanas,[11] found there to be a significant relationship between turbulence and the incidence of injury among cabin crew. Fractures affecting feet and ankles were found to be the most common injury.

All cabin crew industrial injuries (not just those affecting the lower limbs) are known to cause stress to the affected individuals and also place a financial burden and logistical strain on an airline's roster system.[12,13] Research conducted on a sample of 33 cabin crew by Mulay found that "82% of the flight attendants had work-related pain".[14] Pain in more than one body region was also commonly reported. Feet pain was commonest (58%). Given the identified stresses, revealed in the relevant literature, placed on cabin crew's lower limbs, it was felt that there is a justified case for investigating the incidence and causative factors of lower limb injuries. Any findings from this communication will aim to complement those of previous research in this field and support further associated research being carried out. It is hoped that such research will impact evidence-based practice thus ensuring the introduction of preventative measures to minimize the risk of lower limb industrial injuries among the said population.

Observations at a leading airline in the Middle East found that cabin crew were more susceptible to MSK injuries and symptoms than individuals who did not fly. Such observations were in line with other research carried out in this field.[1,2,3,6,7,9,10,11,14] Many of the industrial injuries occurring amongst the airline's cabin crew were frequently related to the lower limbs. Problems associated with poor foot mechanics often present as symptoms in the lower back, hips, knees, ankles, feet, and connective tissues in these areas. To ascertain further details regarding the incidence and nature of such symptoms, an informal evaluation was conducted whereby ab initio (newly recruited cabin crew) lower limb biomechanics were screened over a 12-month period.

Methods

Screening of 250 ab initio cabin crew over a 12-month period revealed many to have abnormal foot mechanics. Inclusion criteria were devised to reflect the cabin crew population (and company requirements) of the airline at large. That is, both male and female crew of all cultures and nationalities were invited to participate. Additionally, those within a healthy BMI range and aged 22-30 years were also included. Participants were approached whilst selecting their new uniforms and were screened in the same location immediately afterward. No financial incentives were given, and all participants were verbally assured that their identity would not be revealed upon documenting any findings. Being new recruits, all participants were keen to engage. The screening involved a Podotech electronic dynamic gait analysis (Fig i), informal verbal communication, detailing concerns and relevant information, and a check of lower limb range of motion. Whilst many were asymptomatic and/or compensating for such abnormalities at this early point in their career, it was noted that many crew started to develop symptoms after they started to fly.

Research suggests that the occupational role cabin crew assume, along with the wearing of a corporate style shoe, fatigue and physiological changes over 10,000ft altitude are largely responsible for the apparent rise in symptoms following the commencement of a flying career.[8,11] Tyaryanas has indicated that "the number of flight attendant turbulence-related injuries is on the rise".[11] Specifically, with regard to footwear and the incidence of lower limb medical issues, Barnish and Barnish in their systematic review

found high heeled shoes to be a contributory factor to the incidence of hallux valgus, musculoskeletal pain and first-party injury.[8]

Figure i: Electronic Dynamic Gait Analysis

Results

Our screening found that 34% of the crew were found to have an MSK podiatric issue with 30% requiring orthoses. Of the 34%, 30% of this group had footwear issues (mostly either an incorrect size or discomfort). All results were recorded on a 'yes/no' tick sheet with a comment line detailing biomechanical or footwear issues.

Besides indicating the prevalence of injuries, the screening of cabin crew also served to highlight the contributory common biomechanical problems that existed among the sample group.

Six common conditions were noted amongst the crew:

1. Hypermobility
2. Over-pronation with/without secondary issues including plantar fasciitis
3. Forefoot Equinus
4. Morton's Neuroma / Intermetatarsal Bursitis
5. Plantarflexed 1st Ray – with (functional) hallux limitus
6. Achilles Tendonitis

Resource management meant that it was necessary initially to focus on rehabilitating those crew who were symptomatic as opposed to taking a preventative approach. Referring patients to external podiatry clinicians had historically proven to be a costly exercise since such clinicians lacked industry specific knowledge (uniform requirements, the physiological effects of altitude and occupational role etc.) and were often prescribing orthotics that could not fit into shoes. Such orthotics were therefore not tolerated well and were not worn.

Adopting a holistic approach to rehabilitation which included not only occupational or rehabilitation medicine and physiotherapy but also podiatry – all of which had an aviation focus, proved necessary. The inclusion of podiatry in a treatment regime meant that patients were frequently given a longer-term solution to an underlying cause of their symptoms.

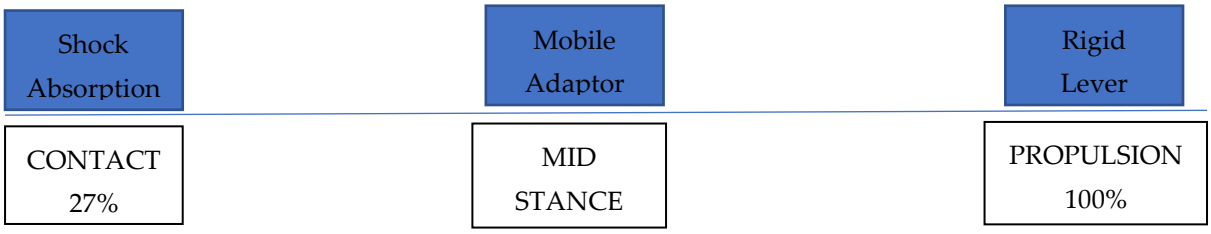

Figure ii: Gait Cycle

Discussion

Lower Limb Biomechanics Theories and Advances:

Much research has been carried out by Frowen et al,[15] Horwood,[16,17] Kirby,[18,19] plus numerous other podiatric clinicians that endorse the use of prescription insoles, or orthotics to improve lower limb biomechanics. Effective orthotic prescription requires an understanding of the human gait cycle and lower limb biomechanics during this cycle (Fig ii).

Failure of the foot and ankle to move in an expected direction can place stress on alternative joint groups and soft tissues as an attempt to compensate for abnormal biomechanics occurs. Orthotics help to promote better foot biomechanics by redistributing forces placed through the lower limbs. This is achieved by placing the foot in an alternative position to that which it may naturally assume.[15]

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Many podiatrists prescribe bespoke orthotics that are manufactured according to the 'Root Theory'. One of Dr Merton Root's theories regarding foot function in 1966 states that since the sub-talar joint (STJ) is in a neutral position at the mid-point of mid stance, valgus or varus tendencies of the forefoot or rearfoot whilst in an STJ neutral position can be easily detected whilst the foot is this position. Orthotic manufacture based on this theory requires the foot to be manipulated into a STJ neutral position.[15]

Since many orthotics prescribed today are done so in accordance with Root Theory and are made from harder materials such as polypropylene, they are not tolerated by many patients choosing to (or who must) wear particular footwear styles including court shoes or slip-ons. It is therefore crucial that more up-to-date research be considered, and alternative materials be utilized when manufacturing orthotics in order to achieve desirable outcomes.[15] Such considerations would be of obvious benefit to the sample group in question, namely cabin crew.

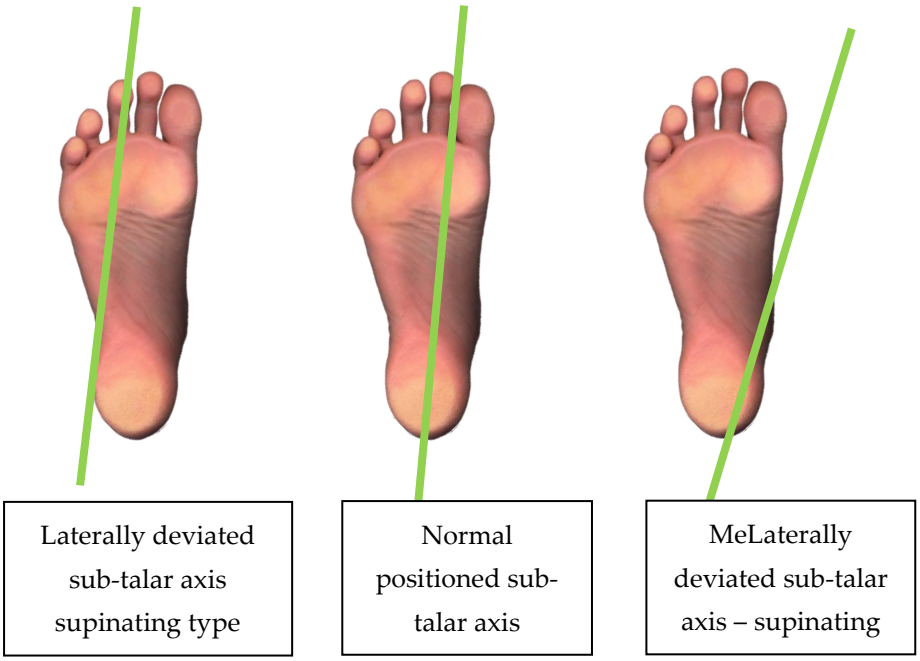

Figure iii: Sub-talar Axis Position in a Supinating, Normal and Pronating Foot Type

Extensive research carried out by Kirby explains an alternative, newer model to foot function and gait that allows for thinner orthotics to be manufactured.[17,18] Such orthotics also facilitate a better quality of movement within a dynamic foot. Introducing the concept of a 'sub-talar axis' in the

1970's, his research has prompted a growing number of podiatrists to reconsider the lower limb function during human gait. His work bears recognition of the fact that the STJ complex is, in fact, in a neutral position at several points during the gait cycle – not just at the mid-point of midstance.[17,18] He refers, instead, to a sub-talar axis. Deviations of this axis can occur in a foot that's over-pronating or over-supinating (Fig iii).

Orthotics manufactured based on Kirby's sub-talar axis model can ultimately be thinner than those made according to the traditional Root Theory since the amount of force required to achieve a particular moment, is significantly less.[17,18] To explore this concept further, it is necessary to consider the following equation:

MOMENT = FORCE X DISTANCE

Where,

moment = movement

force = ground force

distance = distance of lever arm.

(The lever arm is the perpendicular distance from the line of application of the force (i.e., medial aspect of the foot) to the sub-talar axis) (Fig iv).

Traditional orthotics manufactured according to Root Theory have postings that are not perpendicular to the lever arm, thereby reducing the angle between the lever arm and the sub-talar axis. In order to achieve the same moment as those orthotics manufactured according to the sub-talar axis model, a greater amount of force is required. This is achieved through the application of thicker postings.

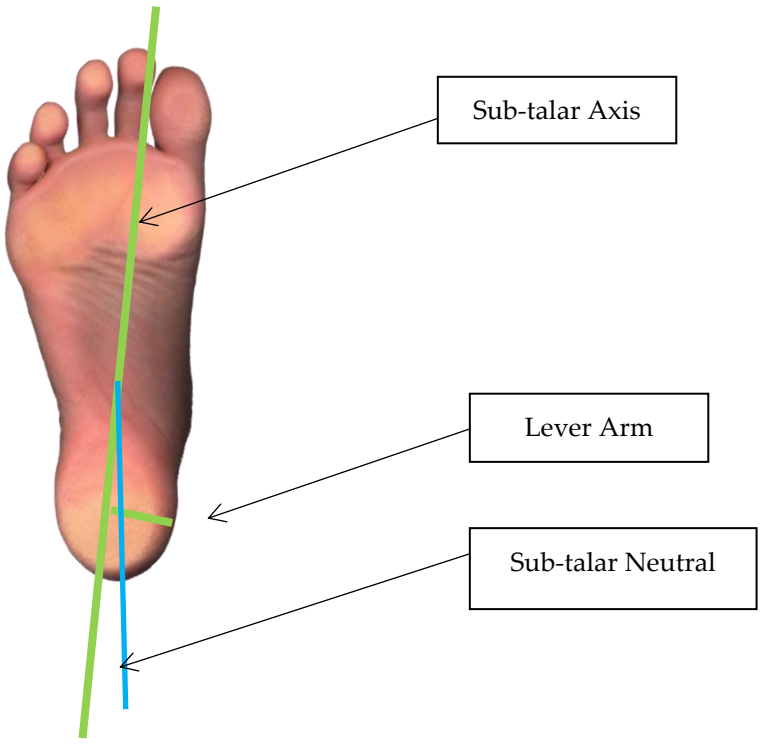

Figure iv Sub-talar Axis and Neutral Positions

A Need for Adequate Care:

Since cabin crew screening highlighted a need for adequate MSK podiatry care and orthotic provision; the sourcing of orthotics that were manufactured in accordance with Kirby's theories of foot function and that were made from a softer, yet durable and supportive material, was deemed a necessity by the airline medical clinic. The material chosen for this purpose was high density ethyl vinyl acetate (EVA). With postings applied to an EVA shell that were parallel to a sub-talar axis, thinner orthotics could be prescribed that were tolerated well and promoted a better quality of movement within the foot. As expected,

participants assessed in our evaluation were subject to vertical forces at heel strike. The wearing of EVA orthotics in their uniform shoes, although did not negate such forces, they did allow the foot a longer period to adapt to such forces.

Besides ensuring adequate provision of orthoses, podiatric interventions also allowed for a better understanding of secondary issues. At the airline in question, cabin crew were frequently found to wear shoes that did not fit their feet properly. Education regarding this matter therefore enabled individuals to make better footwear choices that were more conducive to their lower limb health needs. Additionally, it was noted that often common foot and ankle conditions were mismanaged by other medical staff. Often patients in this instance were recommended to wear a style of shoe that was not the best choice in terms of rehabilitation. Another observation was that there seemed to be a requirement for guidance among uniform staff regarding the quality and manufacture of shoes. Such matters were addressed in part, with proposals to develop training and education plans, also being devised.

Ground staff, who were required to wear PPE, were also found to have issues with safety shoes. Necessary guidance was given by the aviation podiatrist to airport managers and staff, again regarding fit and quality. Many of the airport staff wearing safety shoes had Type II Diabetes, which created a further need for podiatric intervention.

Of course, the skills of a podiatrist extend beyond the realms of MSK care and footwear advice. Many patients presenting to the airline podiatry clinic in question were found also to have soft tissue lesions (some of which were caused by poor foot mechanics). Some of the soft tissue lesions were also due to the wearing of inappropriate footwear (often footwear was inappropriate because it was too big). With appropriate interventions, whether it be MSK care, education or provision of better quality and styles of shoes, many soft tissue problems could also be avoided in the first instance. An additional factor observed in our evaluation was that differences existed in the number of crew presenting with lower limb issues amongst various cultural and gender groups.

Limitations

Conducting a mixed methods research project would have allowed qualitative data to be extrapolated alongside quantitative data. Further, considerations were not given to lifestyle factors or footwear worn outside the work environment. Although it was anticipated that such factors would have influenced the overall findings, the time constraints imposed meant that it was not possible to consider all variables. Additionally, comparisons with senior crew and those from other airlines would have been beneficial.

Conclusions

Aviation podiatry is a new concept within the aerospace medical industry. Although the evidence referred to was gathered from one airline; the airline in question is one of the largest, globally, with over 20,000 cabin crew, representing a diverse range of nationalities and cultures. It is likely, therefore, that similar needs would be identified in other airlines. With an increase in commercial air traffic and a requirement for more cabin crew, or for increased demands to be placed upon existing cabin crew, it is hoped that aviation podiatry will soon be recognized as being a vital part of aviation cabin crew's health care.

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