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Contents lists available at ScienceDirect

Diabetes & Metabolic Syndrome: Clinical Research & Reviews

journal homepage: www.elsevier.com/locate/dsx

Application of tele-podiatry in diabetic foot management: A series of illustrative cases



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ARTICLE INFO

Article history:

Received 30 September 2020

Accepted 9 October 2020

Keywords:

Telemedicine

Tele-podiatry

Diabetic foot triaging

Diabetes mellitus

Pandemic

ABSTRACT

Background and aims: Telemedicine had been proposed as a tool to manage diabetes, but its role in management of diabetic foot ulcer is still evolving. The COVID-19 pandemic and related social restrictions have necessitated the use of telemedicine in the management of diabetic foot disease (tele-podiatry), particularly of patients classified as low-risk.

Materials and methods: We present a report of three cases of varied diabetic foot problems assessed during the present pandemic using different forms of telemedicine for triaging, management of low-risk cases and for follow-up.

Results: Tele-podiatry was effective in the management of low-risk subjects with diabetic foot ulcer, and also useful in referral of high-risk subjects for hospital/clinic visit, facilitating proper management. It also helped in the follow-up of the cases.

Conclusion: Telemedicine is a good screening tool for diagnosing and managing low-risk subjects with diabetic foot problems, and also enables a triaging system for deciding on hospital visits and hospitalization. Telemedicine offers several benefits in the management of diabetic foot disease, although it also has some limitations. Based on our experience during the pandemic, we recommend its judicious use in the triaging of patients of diabetic foot disease and management of low-risk cases. Future innovation in technology and artificial intelligence may help in better tele-podiatry care in the time to come.

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1. Introduction

The occurrence and spread of the Coronavirus induced disease (COVID-19) has posed a public health challenge worldwide [1]. The care of people with non-COVID related chronic health conditions, including diabetes, has become an important consideration during the pandemic [2]. The pandemic-related restrictions resulted in difficulties and apprehensions among the people while commuting to hospitals. Accordingly, various governments, including the Government of India, have supported the use of telemedicine via various advisories [3]. Telemedicine is the delivery of health care where distance is a concern, by health care professionals using

technology for disease management and improving health [4]. Telemedicine can be particularly useful in the management of diabetes, as demonstrated in a study of type 1 diabetes [5].

Diabetic foot is one of the catastrophic complications of diabetes, as it may lead to significant morbidity and mortality. Telemedicine may offer a system of triage (prioritizing patients based on severity of the condition) in diabetic foot (DF) management. As nearly 94% of people with DF may fall in 'stable' category [6], could they be managed remotely via telemedicine? The remaining fall into guarded and serious or critical category [6]. These two categories would definitely need to visit the hospital for active interventions.

We report our experience in managing three varied cases of diabetic foot, which elucidate the feasibility of this 'triage' concept to the real world. We will also discuss the pros and cons of telemedicine or "tele-podiatry" in diabetic foot management.

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Fig. 1. Photographs of case 1. **1a:** Wound on the tip of the left big toe at initial presentation. **1b:** Wound on the tip of the left big toe healed on the 4th day following the tele-podiatry consultation.

2. Case 1

A 66-year-old gentleman presented for an online consultation with a toe injury. He has had type 2 diabetes mellitus for 10 years. He also had peripheral neuropathy since many years. He was taking a combination of insulin and oral anti-diabetic drugs (OADs) for diabetes. He monitored blood glucose levels regularly and visited a doctor for regular diabetes check-ups.

During the pandemic, he sustained an injury on the left big toe, for which he self-dressed the wound thrice daily with a topical antibiotic cream (sodium fusidate) for the initial two days. On the third day he found the wound to be oozing with a yellowish discharge, for which he consulted the physician at our hospital online, in which he described the incident and also shared an image of the wound (Fig. 1a).

His blood glucose levels were under control, and there was no history of fever. On inspecting the image, the wound appeared red; there was no redness to be seen surrounding the wound. He was assured that the wound was clean, and advised to do once daily dressing with the same topical antibiotic cream after cleaning with normal saline, and cover the wound with sterile dressing.

He was counseled to offload (to relieve pressure from the weight-bearing area) the affected foot for a week and instructed to take a course of oral antibiotics (amoxicillin and clavulanic acid 625 mg) thrice a day for 5 days.

He was directed to be vigilant and asked to inspect his feet daily

for any ominous signs like redness surrounding the wound, yellowish discoloration on the surface of the wound, pain, swelling, high blood glucose levels, fever with chills, or any other discomfort. In case of any of the aforesaid symptoms, he was asked to report immediately or visit a nearby doctor. On the fourth day, he corresponded online with a photograph of the foot. After seeing the image, it was concluded that the wound had healed (Fig. 1b). For about nine weeks now, he has remained ulcer free. He was advised to follow foot care practices including foot hygiene, daily examination of foot, applying emollient and use of recommended footwear indoors along with cotton socks.

3. Case 2

A 73-year-old lady made a visit to the hospital during the coronavirus pandemic with severe pain in the right leg and foot. She had been diagnosed with type 2 diabetes mellitus since 38 years. She was taking OADs for her diabetes and the blood glucose levels were under control. There was a history of peripheral neuropathy, peripheral vascular disease, healed diabetic foot ulcer, and amputation of both big toes and also the right second toe.

On examination, she was afebrile, blood pressure and pulse rate recorded were normal. There was a large infected callus on the right forefoot near the first metatarsal head (MTH) with pus collection, surrounding maceration and mild redness (Fig. 2ai and 2aaii). The foot was warmer than the contralateral side and slightly edematous. She was advised about the need for bedside debridement and the importance of offloading, crucial to heal the wound. Post debridement, the wound looked clean (Fig. 2b).

Keeping in mind her age, long-standing diabetes, and the high risk of contracting COVID-19, the patient was advised to carry out the dressing at home. She was educated about alternate day dressing and prescribed broad spectrum oral antibiotics (amoxicillin and clavulanic acid 625 mg thrice daily) for a week. She was asked to follow up by sharing the photographs of the wound and via online consultation. Following regular dressing, offloading measures and regular online assessments, the wound healed in about 40 days (Fig. 2c).

Following healing, she was counseled on the importance of foot care and asked to follow basic foot care precautions. On discussion it was found that the hard area on the foot reportedly became soft, though this aspect could not be assessed by photographs. Since more than seven weeks, she remained wound free.



Fig. 2. Photographs of case 2. **2ai and 2aaii:** Infected ulcer on the plantar aspect of right forefoot near first metatarsal at the initial presentation. **2b:** Wound on the plantar aspect of right forefoot near first metatarsal post debridement. **2c:** Wound completely healed on 40th day following regular follow-up via online consultation and advice.



Fig. 3. Photographs of case 3. **3a:** Dry eschar on the right heel **3b:** Infected wound on the right heel (post debridement) operated elsewhere. **3c:** Infected sutured wound with slough and pus collection on the right heel at first presentation. **3d:** Post bedside debridement of the right heel wound. **3e:** After 15 days, wound was improving with good granulation tissue and slough was present. **3f:** After 45 days of dressing and offloading, wound improved well with good granulation.

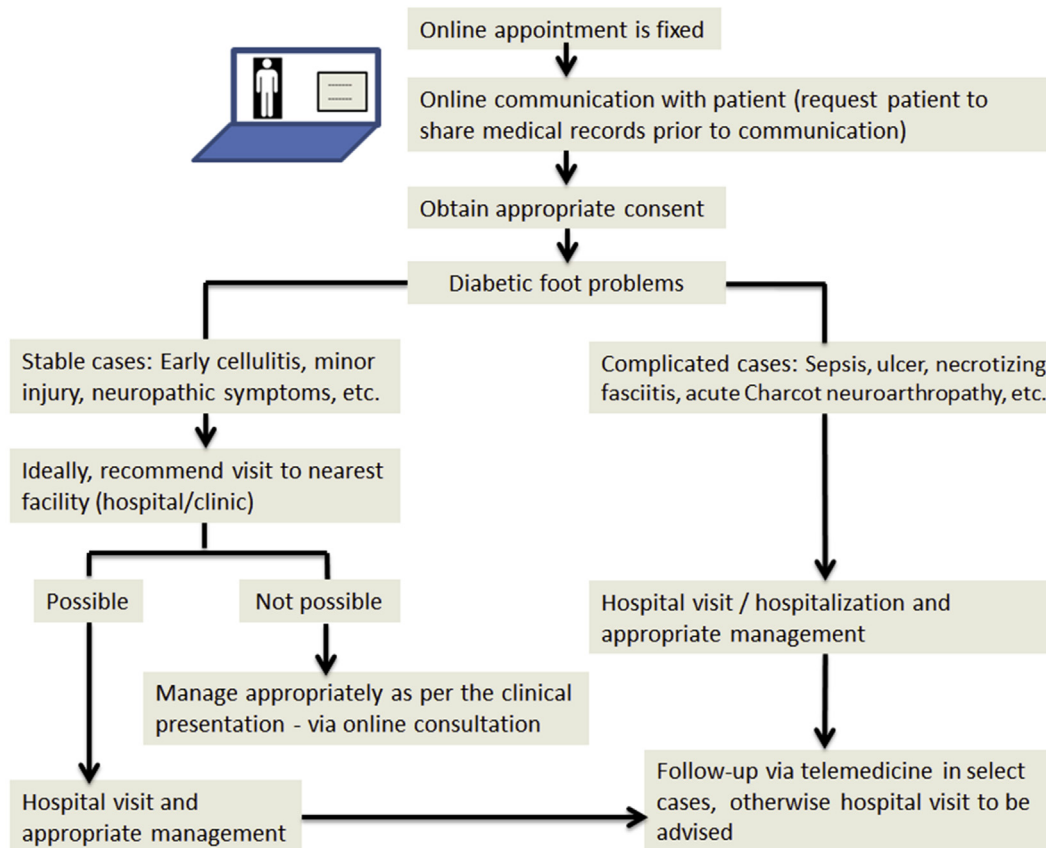


Fig. 4. Approach to a patient with diabetic foot disease using tele-podiatry - a proposal.

4. Case 3

A 79-year-old gentleman was a case of type 2 diabetes mellitus

diagnosed about 37 years back, had been on OADs, and also diagnosed with dementia since a year. He lived in an old age home, and was bed-bound. He was suffering from a foot sore since two weeks.

Table 1
Summary of the management of the cases using Tele-Podiatry.

| Case No. | Presenting findings | Telemedicine tool used | Final diagnosis | Utility of tele-podiatry |
|----------|--|---|---|--|
| Case 1 | Wound on the left big toe following an injury | Email, images shared via email/text messaging app | Superficial ulcer on the left big toe with no signs of infection | <ul style="list-style-type: none"> • Could avoid hospital visit during pandemic • With good rest the wound healed following tele-podiatry consultation |
| Case 2 | Infected callus on first metatarsal head (MTH) | Video call and messaging app | Large infected callus on the right forefoot near the first MTH with pus collection, surrounding maceration and mild redness | <ul style="list-style-type: none"> • For the initial assessment and debridement of the wound, she presented to the hospital • Follow-up was possible via tele-podiatry and guided home dressings |
| Case 3 | Infected right heel ulcer | Email, audio call and images shared online | Infected sutured wound with slough and pus collection on the right heel | <ul style="list-style-type: none"> • The tele-podiatry assessment confirmed need for hospital visit and debridement. • The post discharge follow-up could be completed via tele-podiatry |

During the pandemic induced restrictions, his son contacted us on phone and shared the details of his father’s condition with photographs of the wound online for an opinion. The son felt that the wound was not showing any signs of improvement and felt that the care that he needed for the wound was not being provided at the local level. The patient had history of pressure sore on the right heel for two weeks, which looked to be a dry eschar on the image (Fig. 3a), and which may have subsequently got infected. He had undergone left heel debridement elsewhere by a local doctor a week ago, before contacting us. On inspecting the image (Fig. 3b), we found that the wound looked infected, and advised him to get his father promptly to the hospital, to prevent any major adverse event. The next day he was brought to the emergency department of our institute. It was ascertained that there were no symptoms related to COVID-19, and no history of exposure. Upon physical examination, he was afebrile, pulse rate and blood pressure were normal. Based on the triaging, he was prioritized for management, considering a limb threatening infection.

A multi-disciplinary diabetic foot expert team examined the patient, and it was ascertained that there were no clinical signs of sepsis. His pedal pulses (dorsalis pedis and posterior tibial arteries) were very weak, foot swelling was present, and there was a foul smell. The wound was sloughy with pus discharge and was sutured (Fig. 3c). Probe to bone test was negative but the wound was deep. X-ray of the foot was negative for osteomyelitis. Arterial Doppler showed atherosclerotic changes. The poor prognosis of the wound, need for multiple debridements and risk of worsening of the infection were all discussed. His son consented for further treatment.

Bedside debridement was done (Fig. 3d), followed by dressing with papain urea based ointment and local antibiotic gel consisting of metronidazole. Considering his age and the risk for contracting COVID-19, his son was advised to get the follow-up dressing done at home daily, and was also advised offloading of the heel, so that the wound did not touch the bed. He was advised to share the images of the wound online. After 15 days his son shared the wound image (Fig. 3e) online, which showed some spikes of sloughy tissue on the wound, but the wound was improving well with good granulation tissue. He reported no other problems, and was advised to continue the dressing. After 45 days, the wound was much better and it showed granulating tissue (Fig. 3f).

A summary of the management of the three cases using tele-podiatry is given in Table 1.

5. Discussion

The ongoing COVID-19 pandemic has posed a challenge for the management of diabetes, and particularly of diabetic foot problems. At the same time, it has created opportunities for implementing telemedicine solutions. The advantages of telemedicine are: a) It

can be accessed from home using a smartphone, tablet or computer; b) It is economical; c) It can help in a range of medical conditions. The Government of India has encouraged telemedicine, particularly during this pandemic period [3,7].

Many studies have indicated that telemedicine can be successfully implemented to improve outcomes in patients with diabetes. A meta-analysis of results from 55 randomized controlled trials found that compared to conventional care, telemedicine was more effective in improving treatment outcomes for patients of diabetes, especially for those with type 2 diabetes [8]. Garg et al. found telemedicine as an effective approach for the management of patients with new-onset type 1 diabetes during the COVID-19 pandemic [5].

Telemedicine has become an important tool during the pandemic. Given that people with diabetic foot problems may not find it easy or convenient to visit hospitals during the pandemic, it is possible that telemedicine for diabetic foot management could be a possible solution. In our small series of three cases, we utilized telemedicine for diabetic foot management. One of the patients with a small ulcer on the toe was managed remotely. The second patient successfully utilized tele-podiatry for follow-up consultation. In the third case, telemedicine could successfully identify the problem and its urgency and help call the patient for hospital visit promptly. In this case, telemedicine was also useful in follow-up after initial hospital treatment.

In our experience therefore, telemedicine may be a useful tool in diabetic foot care, but only as an initial assessment tool. Telemedicine may help identify high-risk subjects requiring active intervention at a hospital, like case no 3. Cases like acute Charcot neuroarthropathy may be difficult to diagnose through telemedicine and would require proper evaluation in a hospital. Low-risk patients with diabetic foot problems may be identified and treated via a telemedicine approach. In our case series, as documented in Table 1, we have chosen a variety of telemedicine tools depending on the patients’ need and convenience.

Similar to our experience, remote management of diabetic foot problems has been facilitated with the help of photographic images in an earlier study. This study showed the feasibility of telemedicine in early detection of foot problems [9]. The costs of telemedicine in treating diabetic foot disease may be similar to standard care [10]. Telemedicine has been shown to be effective in superficial ulcers, but data on its diagnostic effectiveness in deeper ulcers remains to be established [11]. However the use of diabetic foot images as a standalone diagnostic instrument has not shown to be efficacious [12]. All these points must be remembered while practicing tele-podiatry, and the results of our case series highlight most of these points.

If telemedicine is utilized for diabetic foot care, its limitations must be recognized. They include: a) Telemedicine may have limited value in overall clinical and hemodynamic assessment of a

patient with diabetic foot; b) Telemedicine images or videos may not provide accurate estimation of the depth of the diabetic foot ulcer; c) A dark colour of skin may prevent the redness and cellulitis from being detected on photograph; d) Telemedicine would also not help in ascertaining consistency of any swelling, as this requires palpation; e) People with diabetic foot disease may have other associated problems such as leukocytosis, hyperglycemia, renal failure and impending sepsis, which would be difficult to detect via online consultation; f) For elderly people with problems in vision, hearing and cognition, a telemedicine based assessment for diabetic foot lesions may be problematic; g) In developing countries like India, there may be problems of internet connectivity, hardware availability and archival of consultation, which could also have potential medico-legal implications. In future, artificial intelligence and machine learning could be utilized to study clinical phenotypes as well as foot images for better management.

Nevertheless, from our series, it is clear that a telemedicine consultation with appropriate images/videos, combined with an assessment of other parameters could help in a triaging system. Low-risk subjects can be managed satisfactorily at home and higher risk subjects can be advised a hospital/clinic visit, and can then also be followed up.

We suggest the possible approach to a patient with diabetic foot disease using tele-podiatry as given in Fig. 4. We feel that following the course of action given in the diagram based on the triaging principle and tele-podiatry could lead to better management, particularly during the present pandemic.

6. Conclusion

The pandemic and the resultant restrictions in mobility have led to difficulties for people with diabetes, particularly for those with diabetic foot disease. As our case series suggests, telemedicine or 'tele-podiatry' may be a useful tool for initial assessment and triaging. Every effort must be made to obtain comprehensive clinical and laboratory data, as image-only-assessments may be inadequate and problematic. Telemedicine may help identify and counsel higher risk subjects with diabetic foot disease who may need hospital visit for management. Newer technologies and future research especially utilizing artificial intelligence could help identify specific subgroups of subjects who may either need hospital visit, or who are likely to improve with home based care.

Source of funding

None.

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