between antenna and human tissue, efficiency can be improved. [9]

**3.4** Textile based wearable antenna can absorb liquid material around it. Dielectric constant of absorbed material can affect the resonant frequency. This effect can be minimized by choosing appropriate material for antenna design. Performance of Antenna made with shield it conductive fiber is better than antenna made with copper conductive sheet [5].

**3.5** EBG based antennas have more advantages than conventional ground plane antennas. Surface waves can be decreased by EBG based ground plane. So, radiation in backward direction is decreased. And because of it, SAR is decreased. Bending and crumpling effect in EBG based antenna is lesser than conventional antennas [10].

**3.6** Requirements for the materials for wearable antennas in real life system are the temperature tolerance, durability, physical abrasion, water absorption, and stress with the structural characteristics of the fabric to maintain the electrical functionality under the environmental condition. Textile cover can be used to protect antenna in real life system [11].

**3.7** By adding conductive layer or developing antenna based on EBG ground plane, we reduce radiation in backward direction. So, multiple antennas can be located around the body to get radiation in all direction.

**3.8** When high performance is required in terms of antenna gain and radiation pattern, multi antenna system can be used. Automatic tunable circuits and reconfigurable antenna could be implemented in wearable antenna to minimize detuning effect.

**Table 1:** Comparison of patch antenna with conventional ground plane, patch antenna with EBG based ground plane and patch antenna with EBG based ground plane with dielectric cover.

| Issues | Patch antenna with conventional ground plane | Patch antenna with EBG based ground plane | Patch antenna with EBG based ground plane with dielectric cover |
|---|---|---|---|
| 1. Dielectric properties of material | Not improved | Not improved | Not improved |
| 2. Return loss characteristics and radiation characteristics near human tissue | Good isolation | Better isolation | Better isolation |
| 3. Antenna performance under bent condition | Not solved | Less effect | Less effect |
| 4. SAR and temperature value | Good reduction | Better reduction than conventional ground plane antenna. | Better reduction than conventional ground plane antenna. |
| 5.Antenna performance under wet condition | Not solved | Performance is Partially affected. | Performance is less affected than other antennas. |
| 6. Environmental effects | Not solved | Not solved | Better performance than other antennas. |

## 4. Conclusion

Conventional techniques for the designing and characterization of antenna should be modified. Design challenges of wearable antennas are need to consider at the time of antenna design. Good isolation between antenna and human body is produced by EBG based antenna. A textile cover on antenna also can be placed to make antenna water proof and save antenna from environmental effects. When high performance is required in terms of antenna gain and radiation pattern, multi antenna system can be used. For the long term reliability of textile, washing and dry cleaning should be further improved. Automatic tunable circuits and reconfigurable antenna could be implemented in wearable antenna to minimize detuning effect.

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